MARKET IMPACT OF NEW SOFTWARE PRODUCTIVITY TECHNIQUES

INPUT

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MARKET IMPACT OF
NEW SOFTWARE PRODUCTIVITY TECHNIQUES

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MARKET IMPACT OF
NEW SOFTWARE PRODUCTIVITY TECHNIQUES

EXHIBITS

I INTRODUCTION

I INTRODUCTION

- This report focuses on some major issues and problems that are of high importance in understanding the market impact of new software productivity techniques.

- It borrows concepts and terminology from several other INPUT reports. Two of the most important are: Improving the Productivity of Systems and Software Implementation, November 1980; and Market Impacts of IBM Software Strategies, published in 1984. In addition, the research program for this report is described in more detail in its companion report, New Opportunities for Software Productivity Improvements.

- Improving the Productivity of Systems and Software Implementation was the result of a major INPUT multiclient study. That study identified five major components of a comprehensive productivity improvement program. These components and their definitions are as follows:

    - Commitment to quality was determined to be essential if failures and excessive maintenance were to be avoided.

    - User involvement was deemed necessary to assure quality. This component included:

        - Direct user involvement in both systems development and operations.

- Understanding of what the proper role of the information systems (IS) function is.

- Awareness of how individual user needs fit into company requirements.

- Broad-based management of the IS function was found to be effective in assuring both high quality systems and user involvement through education. It was felt that broad-based management of the IS function would provide top management and users with knowledge of "nontechnical IS fundamentals" and IS management with broader perspective on corporate objectives.

- Effective personnel policies emphasized the importance of employee selection, retention, motivation, and development.

- The right tools were named as a means of achieving productivity, and it was concluded that selection of the right tools is heavily dependent upon the other components of the productivity program. ("Tools" was taken in the broadest sense and included everything from programmer terminals to structured methodologies and information engineering.)

- Market Impacts of IBM Software Strategies introduced the components of General Systems Theory (GST) as it applies to systems software, and defined four strategic periods in IBM's software strategy. GST has four relatively simple components--centralization, integration, differentiation, and mechanization--that all proceed in parallel and therefore lead to complex interaction. In their simplest form, these concepts are defined as follows:

  - Progressive centralization: "Leading parts" tend to dominate the behavior of the system.

- Progressive integration: The parts become more dependent upon the whole.

- Progressive differentiation: The parts become more specialized.

- Progressive mechanization: Some parts become limited to a single function.

- The IBM strategic periods were designated as: systems network architecture/distributed data processing (SNA/DDP), electronic office, expert systems, and custom products. These strategic periods also proceed in parallel, and the labels were derived from IBM primary software emphasis during the relevant period. The fundamental definitions of these IBM strategic periods are as follows:

  - SNA/DDP: This period extends from the present to 1990, and represents IBM's evolutionary distribution of processing and data bases under the SNA umbrella.

  - Electronic offices: This period extends from 1990 to 1995, and is characterized by the automation of office functions to the degree that paper documents become secondary to electronic information flow.

  - Expert systems: This period extends from 1995 to 2000, and will see the beginning of knowledge-based systems, in which software will include necessary information to support individual industries and/or professions.

  - Custom products: This period extends beyond 2000, and essentially represents the necessary integration, differentiation, and mechanization of hardware/software/information required to penetrate the individual consumer market--whether at home or in the office.

- It is within the general structure defined by the productivity components, GST concepts, and IBM strategic periods that the research for this study was conducted. The research base used was as follows:

  - The comprehensive productivity data base developed for the 1980 multiclient study provided the primary research basis. (Fifty companies were visited on-site; over 100 companies and 200 individuals were interviewed; and 1,300 received mail surveys.)

  - In addition, over 50 carefully selected individuals were interviewed by telephone. These interviews were distributed as follows:

    - Thirty companies from the 1980 multiclient productivity study were interviewed.

    - Seven information systems directors from seven major industries that had participated as in-depth case studies for a custom productivity study in 1981 were reinterviewed to determine the status of their productivity improvement programs.

  - The 10 computer services companies who specialize in productivity tools and aids were interviewed.

  - Ten individuals prominent because of their efforts in productivity improvement (or because their specialties may be of significance in advanced tools and aids) were interviewed.

  - In addition, extensive desk research was conducted in areas indicated as promising by past productivity research efforts.

- As a result of the analysis performed for <u>Market Impacts of IBM Software Strategies</u>, it was concluded that the framework of GST concepts and IBM strategic periods would be an appropriate foundation for a refined forecasting

methodology. This report will be the first to employ this new methodology, and it will be explained in detail in the body of the report.

II EXECUTIVE SUMMARY

II EXECUTIVE SUMMARY

- This executive summary is designed in presentation format in order to:
  - Help the reader review key research findings.
  - Provide an executive presentation script to facilitate group communications.
- The key points of the entire report are summarized in Exhibits II-1 through II-6. On the left-hand page facing each exhibit is a script explaining the exhibit's contents.
- It is recommended that the full report be read in order to make most effective use of the summary presentation.

A. IMPACT OF NEW SOFTWARE PRODUCTIVITY TECHNIQUES

- The impact of new software productivity techniques manifests itself in a newly emerging systems development environment. This environment is characterized by:

  - Emphasis upon the establishment of the information center.

  - Increased use of prototyping.

  - The increasing acceptance of personal computers in the corporate environment.

  - The demand for micro-mainframe links to extend the applications of microprocessor technology.

- INPUT calls this new environment Distributed Systems Development (DSD).

- The DSD environment holds great promise because it increases IS responsiveness, gets end users involved in software development, and produces early tangible results.

- However, there are potential problems which threaten to negate the promise. These problems are associated with data/information quality and security, and with performance at both the host and the intelligent workstations.

- While the problems present a challenge, this solution represents an opportunity for an increased market for improved productivity tools and aids.

EXHIBIT II-1

IMPACT OF NEW SOFTWARE PRODUCTIVITY TECHNIQUES

- **Manifestations of Impact**
  - **Information Centers**
  - **Prototyping**
  - **Microcomputer Acceptance**
  - **Micro-Mainframe Links**
  - **Distributed Systems Development (DSD)**
- **The Promise**
- **The Problems**
- **The Opportunity**

B. THE GOOD NEWS

- Not only is the idea of fourth, fifth, and future generation languages (FGLs) being accepted, but the demand for continued advanced language development is beginning to be addressed by the emerging commercial products for artificial intelligence research. Specifically, the interest in expert systems is healthy and should be viewed as a substantial growth opportunity.

- Integration of FGLs with data base systems (and eventually knowledge-based systems) and code generators will enhance both their usefulness and market value.

- Languages and data base management systems (DBMSs) are beginning to migrate to microcomputers, and this will accelerate with micro-mainframe links.

- Systems are getting more user friendly, and users are becoming more computer literate and involved in the systems development process.

- Tangible results in terms of responsiveness for information and output from new systems are becoming available more rapidly. Pressure upon the IS function has been relieved in many instances, and user-IS relations have improved.

EXHIBIT II-2

THE GOOD NEWS

- Growing Demand for Fourth, Fifth, and Future Generation Languages (FGLs)

- Integration of FGLs, DBMSs, and Code Generators

- Extension of FGLs and DBMSs to Intelligent Workstations

- User Involvement

- Tangible Results

C. THE BAD NEWS

- IS management expressed real concern that the quality of data and information in their companies could suffer as a result of the DSD environment. It is anticipated that investment in the DSD environment (both hardware and software) will divert resources from conventional data processing services, while making increased and unanticipated demands upon the central facility.

- The distribution of data bases is felt to be creating a new set of security, protection, and privacy problems before the old ones have been solved.

- INPUT's analysis reveals that there is high potential for counterproductive impacts in the DSD environment, despite superficial indications of improved productivity. Specifically:

  - Essential corporate data may be contaminated and information quality may degenerate to the point of chaos.

  - The systems developed may be of such low quality and/or performance that they are not worth installing. This could result in a higher percentage of systems being aborted later in the development cycle.

  - Just as bad, if not worse, is "eternal" systems development, whereby excess maintenance is hidden in the unending development of partial solutions.

- Whereas most of the anticipated problems are recognized by IS management, DSD is proceeding without control, and, more importantly, some IS managers are waiting to say: "I told you so."

EXHIBIT II-3

THE BAD NEWS

- **Serious Problems Are Anticipated**
  - **Data Base Integrity and Synchronization**
  - **Security, Protection, and Privacy**
  - **Conflicting Reports to Management**
  - **Overburdened Hosts**
- **Counterproductive Systems Development**
  - **Deterioration of Data/Information Quality**
  - **Unanticipated Expense**
  - **Unworkable Solutions**
  - **"Eternal" Systems Development**
- **Waiting for Failure**

D. NEW TOOLS AND AIDS NEEDED TO CONTROL DSD

- Some new tools needed to control quality in the DSD environment are outlined in the report and summarized below. These tools are described primarily because they targeted windows of opportunity created by IBM's software strategy.

  - Information Base Management System (IBMS) is a comprehensive system under proposal for identifying information sources within an organization (including paper-based and human information sources).

  - Document Control System (DOCS) is a necessary subsystem under IBMS that provides for tracking of paper documents and for a smooth transition to electronic offices. (Early use of optical disk for electronic filing is urged.)

  - Data Flow Monitor (DFM) is an advanced network manager that both monitors and controls data flow, with special emphasis upon use of operations research (OR) and artificial intelligence (AI).

- It is INPUT's opinion that OR and AI must be reconnected if emerging expert systems are to be of practical value, and the quality problems of DSD may prove trivial compared to those of early expert systems. There is substantial need for practical research and development to supplement the spin-offs from the academic community.

- Any tool, aid, or software system that does not address the problems of security, protection, and privacy (SPP) will be obsolete once IBM makes its "solution" available. There is tremendous opportunity for an SPP system to handle distributed data bases.

EXHIBIT II-4

NEW TOOLS AND AIDS NEEDED TO CONTROL DSD

- An Information Base Management System (IBMS)
- A Document Control System (DOCS)
- A Data Flow Monitor (DFM)
- "Connected" Operations Research and Artificial Intelligence Tools (OR and AI)
- A Security, Protection, and Privacy System (SPP)

E. FGLs: KEY TO THE DSD MARKET

- FGLs have paved the way for the DSD environment, and future language advances will continue to fuel the market for easy-to-use computer systems. INPUT's expanded definition of FGL includes expert systems as highly differentiated products. (Such systems had been viewed as affecting FGL growth in the late 1980s.)

- Since FGLs fuel the DSD environment, they contribute to the problems associated with that environment. Understanding the control problems will permit the extension and application of FGLs to the solution of control problems and will actually expand the FGL market.

- Some of the proposed tools and aids for controlling the DSD environment can be initially implemented as applications using FGLs as "tools to build tools." This invisible market is substantial.

- The market impacts of IBM software strategies were described in the INPUT report of the same name. That report defined certain anticipated windows of opportunity occurring between IBM's strategic periods--specifically, between the current SNA/DDP period (1984-1989) and the electronic office period (1990-1995). Use Market Impact of IBM Software Strategies to determine specific targets of opportunity.

- IBM has also been identified as a large potential market for software, especially in the electronic office period. Design future tools and aids with that in mind.

EXHIBIT II-5

FGLs: KEY TO THE DSD MARKET

- FGLs Are the Driving Force Behind DSD
- Extend FGLs to Include Control Tools
- Develop the Invisible FGL Market
- Exploit the Gaps in IBM's Software Strategy
- View IBM as a Potential Market

F. EXPANDED FGL MARKET FORECAST

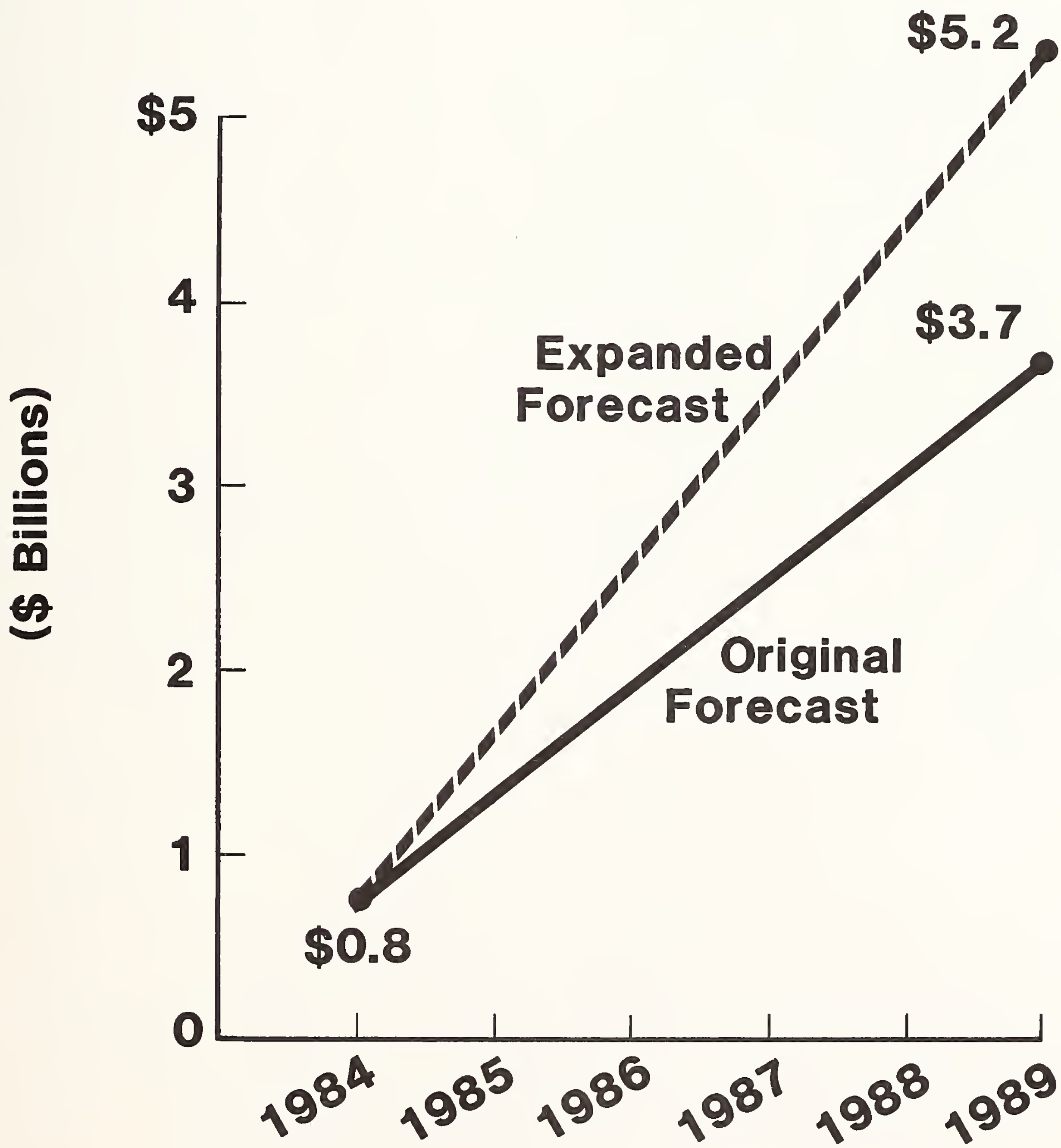
- INPUT's original forecast for the FGL market is contained in Trends and Opportunities in Fourth Generation Languages. That forecast predicted growth from $750 million in 1984 to $3.7 billion in 1989, for an average annual growth rate of 37%.

- By extending FGLs to include control tools and aids necessary for the DSD environment, that potential market is projected to expand to $5.2 billion by 1989, for an AAGR of 47%.

- This report also projects "effective markets," which are the markets remaining after IBM has achieved its share. Effective markets are especially attractive because it is predicted that IBM will achieve only 30% penetration (approximately $1.5 billion), as compared to 41% penetration for the overall applications development market (of which FGLs are a part). This means the original forecast of $3.7 billion represents an effective market.

EXHIBIT II-6

EXPANDED FGL MARKET FORECAST



III CURRENT APPROACHES TO SYSTEMS DEVELOPMENT

III CURRENT APPROACHES TO SYSTEMS DEVELOPMENT

- Through the Information Systems Program (ISP), INPUT stays informed of productivity issues and developments among its client base. It is INPUT's opinion that the major productivity initiatives that have been taken since INPUT completed its comprehensive multiclient productivity study (Improving the Productivity of Systems and Software Implementations, November 1980) fall into the following general categories:

  - Information centers.

  - Prototyping.

  - Personal computers.

  - Micro-mainframe links.

- Whether these initiatives were taken by the IS departments, promoted by hardware and software vendors, or seized by frustrated computer users is immaterial. The result has been that end users have become intimately involved in the systems development process--even to the degree of developing their own systems. INPUT refers to this perceived trend away from highly centralized, IS-dominated systems development as Distributed Systems Development (DSD).

- Theoretically, DSD should result in substantially improved productivity, but INPUT's continuing client contact also indicated that there was some apprehension among IS departments concerning direct user involvement. Therefore, the research for this study and its companion (New Opportunities for Software Productivity Improvements, to be published as part of INPUT's Information Systems Program) was designed to explore both positive and negative aspects of DSD.

- The questionnaire used is included as Appendix A, and it clearly indicates that the purpose of the research was directed toward determining what is being done to both promote and to control the DSD environment. Emphasis was placed on identification of problem areas and of the tools and aids required to facilitate and control software development in that environment.

A. THE CURRENT DSD ENVIRONMENT DESCRIBED

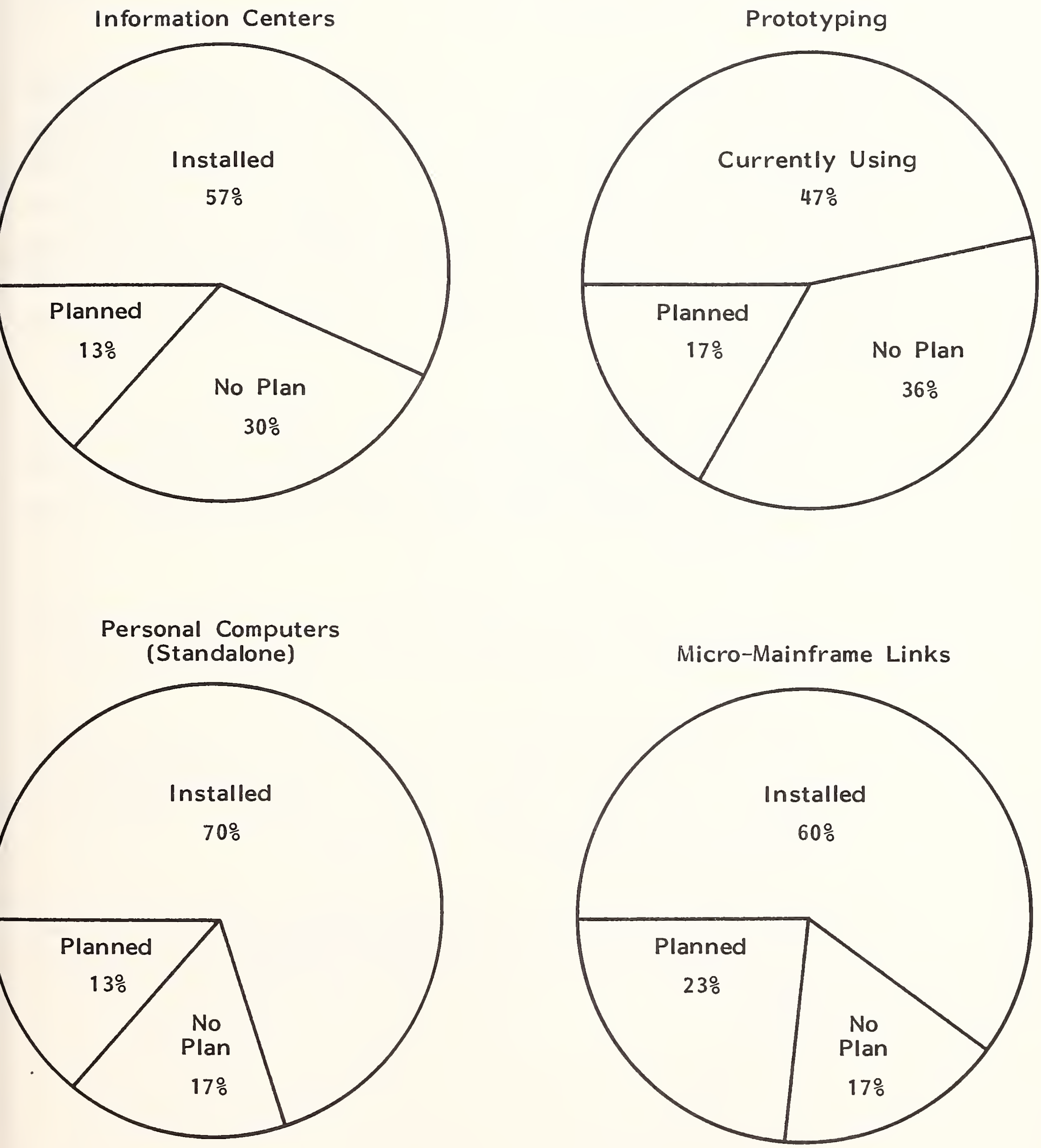
- The trend toward DSD that INPUT perceived among its clients was substantiated by the research conducted for this study, as shown in Exhibit III-1. The following general comments apply to these responses:

    - Information centers, though conceptually vague, are being installed by 70% of respondents. These vary in implementation from dedicated large-scale mainframes (and appropriate data bases) with full-time training staff to conduct user education, down to "computer stores" with minimal user support.

    - Prototyping was referred to by some respondents as "interactive systems development" and "eternal systems development," but nonetheless was being used (or planned) by 64% of respondents.

EXHIBIT III-1

REPORTED IMPLEMENTATION OF DSD ENVIRONMENT
(30 Respondents)



- It is significant that only 17% of respondents stated they had plans for neither personal computers nor micro-mainframe links. This indicates their intention to integrate intelligent workstations into mainframe-oriented networks. IBM indicated its intention in this regard nearly two years ago when it stated: "IBM PC is communications-oriented--the day of the standalone is over."

- Respondents were also asked for the advantages and disadvantages they associated with the various aspects of the DSD environment. The questions concerning advantages and disadvantages were left open-ended and the responses were categorized. A more detailed analysis of these responses is contained in New Opportunities for Software Productivity Improvements, but the results are summarized here to establish the general tone of the DSD environment. There were few surprises. The reported advantages are listed in Exhibit III-2.

  - Information centers were viewed as a means of educating users concerning data processing (DP) concepts, services and problems (39%); in the use of systems (18%); and in obtaining quick response to user requests (24%).

  - Prototyping was felt to have the advantage of getting end users involved (50%) and, significantly, of producing better systems (21%).

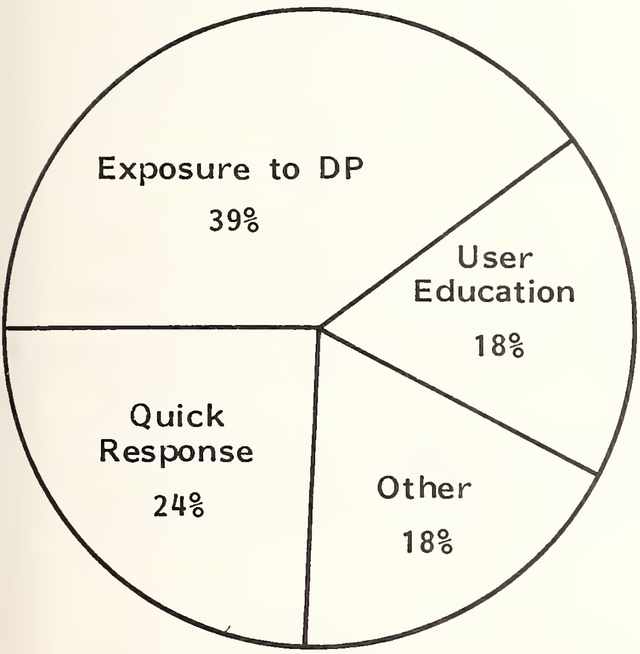
  - Standalone personal computers were seen as allowing users to "control their own destinies" (36%), to generate simple reports (16%), to improve productivity (16%), and to implement cost-effective off-loading of the mainframe.

  - Micro-mainframe links were reported to offer the advantage of access to data bases (67%), and to provide for off-loading of the mainframe (17%).

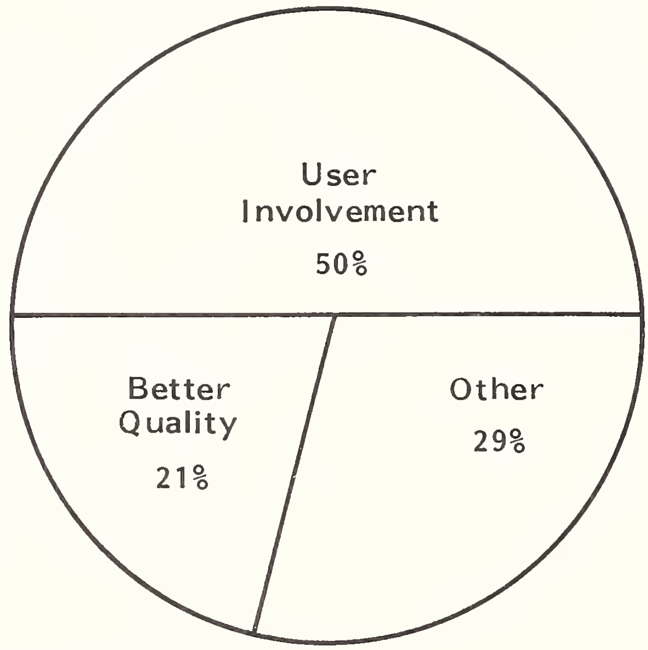
EXHIBIT III-2

REPORTED ADVANTAGES OF DSD IMPLEMENTATIONS
(Percent of Responses)

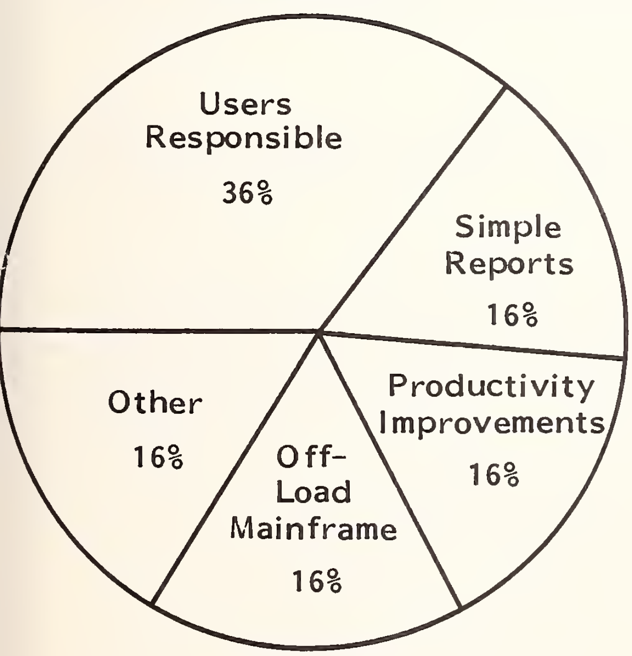
Information Centers



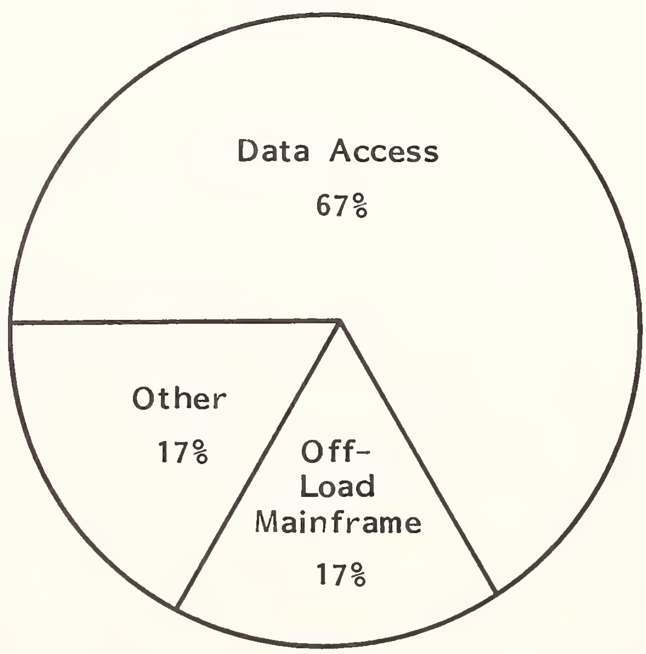
Prototyping



Personal Computers
(Standalone)



Micro-Mainframe Links



- The reported disadvantages were also predictable, but somewhat more diverse than the advantages, which seemed to cluster around the theoretical and publicized benefits of the particular approach or product. Exhibit III-3 presents the most commonly cited disadvantages.

  - Information centers were viewed by IS primarily as requiring additional use of IS resources (35%) and as representing a threat to IS control and standards (10%). However, some vendors and experts expressed two views which are worth mentioning here:

    - It was stated that information centers were IBM's answer to the control of personal computers, and that they were evolving into focal points for the sale of IBM products.

    - There was also the related opinion that information centers were an "external diversion to distract the source of unrest" (the IS department itself).

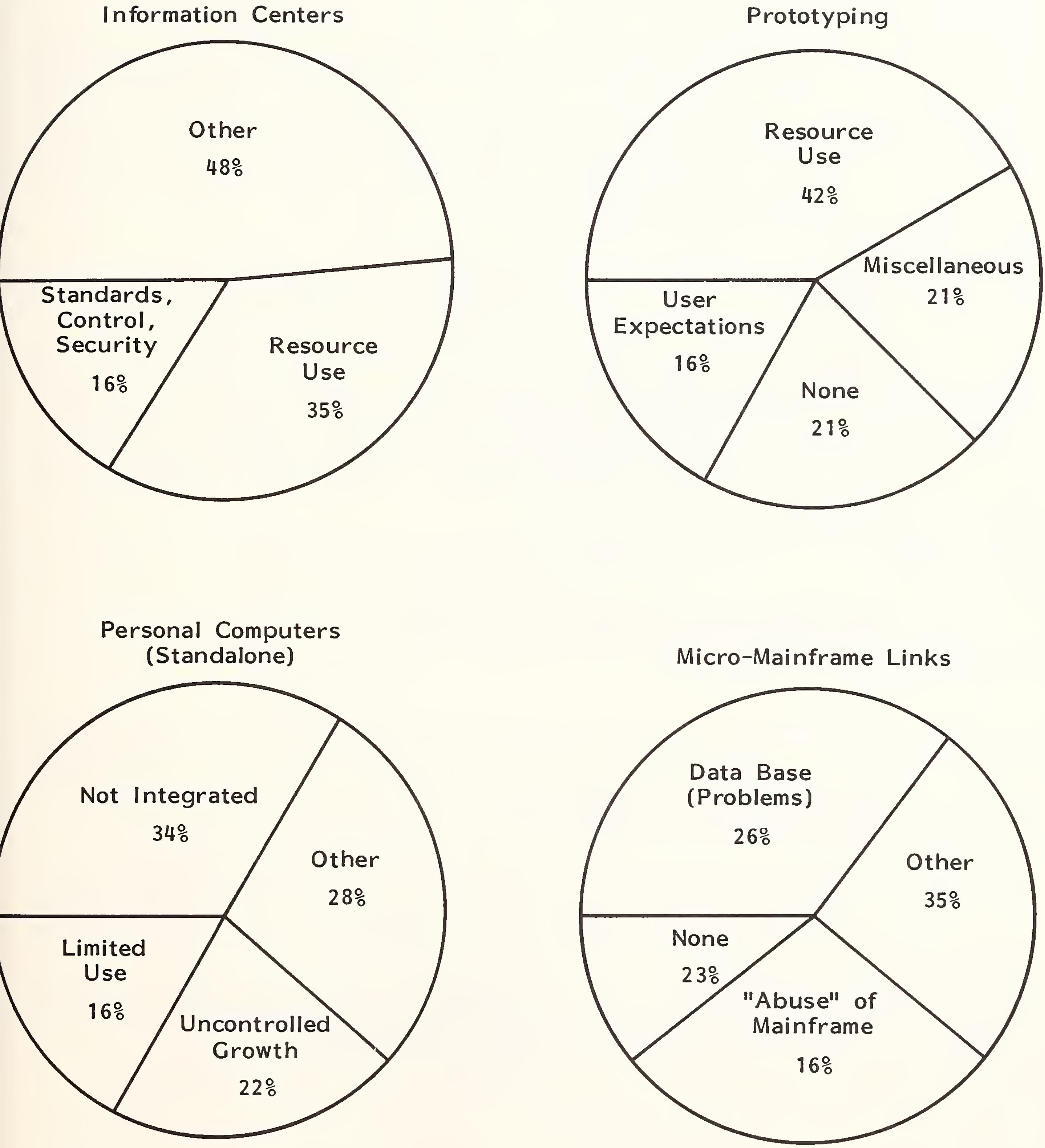
  - Prototyping was considered to be wasteful of resources (42%), and it was also felt that users expected too much from the resulting prototype (16%). However, a significant percent (21%) stated there were no disadvantages. In fact, only a few of the miscellaneous responses focused on two fundamental problems associated with the general DSD environment:

    - It was stated that prototypes were developed without regard for the quality of supporting data.

    - One user confided that both internal and external auditors were beginning to express concern about audit trails in an environment where systems seemed to be going through numerous iterations.

EXHIBIT III-3

REPORTED DISADVANTAGES OF DSD IMPLEMENTATIONS
(Percent of Responses)



- The issue of standalone personal computers elicited a strong reaction from IS respondents who felt the PCs were not integrated with conventional systems (34%) and that PC use was not being controlled (22%). There was also the disadvantage that their effective use was limited by capacity or availability of data (16%).

- Micro-mainframe links were not well understood by IS respondents, but there was a general uneasiness concerning data base problems (26%) and concern that "unreasonable demands" would be made on the mainframe (16%). However, a significant percentage (21%) stated there were no disadvantages to micro-mainframe links.

• Generally speaking, it can be concluded that IS management is so busy implementing and reacting to the DSD environment that they have not had time to analyze either the advantages or disadvantages of what they are doing. The interviews disclosed a not-so-subtle undertone of letting the users discover the problems of systems development the hard way. However, when attention was directed toward specific, potential problem areas, the concern was substantial.

B. THE PROBLEMS IN THE DSD ENVIRONMENT

• IS management was asked to rate certain potential problems in terms of their severity (very serious, somewhat serious, and no problem). The severe problems clustered in three areas:

- Distributed data base management, as manifested by problems associated with data base integrity, synchronization, and security/protection.

- Information flow, as represented by concern about conflicting reports to management and about lower systems quality.

- Mainframe impact, in terms of performance and capacity planning.

- IS management's concerns in these three areas are summarized in Exhibit III-4. More than one-third rated the problem areas "very serious," and less than 20% responded that there were "no problems." The experts' reactions were even more pointed. Here are a few sample comments:

  - "Problems of security/protection have been talked to death but they have not been addressed on an overall basis."

  - "Most programmers and analysts do not have a good understanding of data base management problems...users certainly aren't going to improve the situation."

  - "If management sorts through conflicting information, the problem might get solved--the problem is conflicting action based on conflicting information."

  - "Systems quality is going to suffer because you can't separate data problems from systems quality."

  - "Information flow and all of its ramifications are not understood--period."

C. THE IMPACT OF DSD ON PRODUCTIVITY IN THE SYSTEMS DEVELOPMENT PROCESS

- The major conclusion reached in INPUT's multiclient productivity study in 1980 was that an effective productivity improvement program must be built in a logical manner on a firm foundation. The specific steps to be taken, in order of priority, were as follows:

EXHIBIT III-4

I.S. RESPONDENT RATING OF POTENTIAL DSD PROBLEM AREAS
(Composite Ratings)

- A commitment to quality is indispensable to the development of workable, maintainable systems. It had to be clearly understood that "quick and dirty solutions" do not achieve acceptable results, and that the life cycle costs for machine time and software maintenance are enormous.

- User involvement in the systems development process is necessary at the earliest stages and throughout actual implementation if unacceptable systems are to be avoided.

- Broad-based management of the systems development function is required in order for business plans to be tightly coupled to IS plans. Top management must understand that the business plan cannot succeed without supporting information; subordinate management must understand how their functions (and information systems) interact with those of others; and information systems management must understand the business objectives being supported.

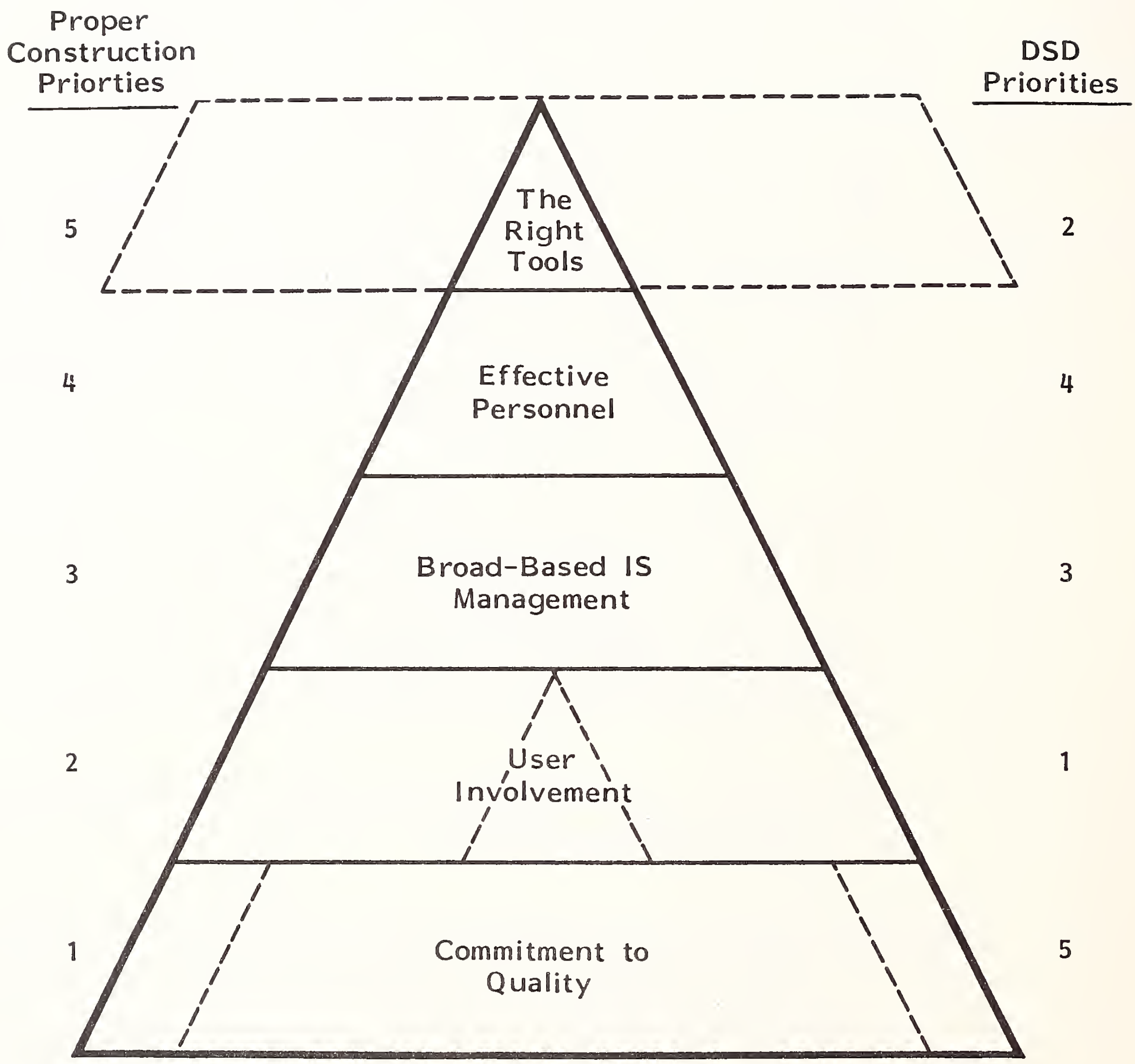
- Effective personnel must be selected, trained, motivated, and retained. Individual productivity varies tremendously from programmers to IS management in the information systems function. It is not possible to buy "solutions" in terms of people--an effective staff can only be built after the business objectives are clearly understood.

- The appropriate productivity tools and aids can be selected only after all of the above has been achieved.

- The approach to building an effective productivity program was depicted in the form of a "productivity pyramid," with "commitment to quality" as the base and "tools and aids" as the capstone, as shown in Exhibit III-5. It is INPUT's opinion that the DSD environment encourages the reconstruction of the productivity pyramid in a highly unstable manner, and has high potential for decreased productivity. The shift in priorities is as follows:

EXHIBIT III-5

THE PRODUCTIVITY PYRAMID
(And Its DSD Reconstruction)



- User involvement is the name of the game in the DSD environment; it has number one priority and has been moved to the base of the pyramid.

- The right tools and aids have second priority and have been moved to the position of importance after that of end-user involvement, where the former capstone forms a balance point for the more important components of a comprehensive productivity improvement program. In essence, the search for a magic productivity improvement tool means that broad-based management, effective personnel, and quality become dependent upon the tools employed; an this is a precocious balance.

- Broad-based management and effective personnel maintain their relative third and fourth priorities in the DSD environment, but they have become less important than the tools and aids being employed.

- Commitment to quality has been relegated to the lowest priority in the DSD environment, where "results" are all important and quality is virtually ignored until the system has been built.

• INPUT believes that this reconstruction of the productivity pyramid is especially dangerous at this time for the following reasons:

  - IBM's highly centralized, host-oriented software strategy as described in <u>Market Impacts of IBM Software Strategies</u> (INPUT, 1984) and its associated performance burden on the mainframe, may mean that the large host systems will not be able to meet the demands of the DSD environment in an economical fashion.

  - There is entropy (i.e., tendency toward chaos) associated with data bases and with the communication of information. The DSD environ-

ment definitely increases entropy to the point where enormous resources will be required to maintain (not to mention improve) the quality of data and management information. Data and information entropy are not currently very well understood, and the probability of systems failure in terms of creating chaos in corporate information flow is quite high. (Data/information entropy was first described by INPUT in a special combined Executive Bulletin for End-User/Corporate Systems, Vol. 2, No. 1, issued early in 1984, and the problem is described in detail in New Opportunities for Software Productivity Improvement--the companion to this report.)

- As dependency upon decision support systems increases and these systems evolve into expert systems, it will become increasingly difficult to identify systems deterioration. Therefore, it becomes essential to restore commitment to quality to its proper place at the foundation of the productivity pyramid.

- The recommendations to IS management in New Opportunities for Software Productivity Improvement emphasized the restoration of the priorities which were initially established in the productivity pyramid. It was pointed out that there was tremendous need for tools and aids to support quality control in the DSD environment, but there was no shortage of tools to facilitate implementation of the DSD environment--in fact, the proliferation of tools and aids is part of the problem. Under any circumstances, neither the availability nor unavailability of tools and aids should relieve IS management from their responsibility for establishing an effective productivity improvement program--including the intelligent use of available tools and aids.

IV TOOLS AND APPROACHES TO PRODUCTIVITY IMPROVEMENT

IV TOOLS AND APPROACHES TO PRODUCTIVITY IMPROVEMENT

A. FOURTH GENERATION LANGUAGES: THE KEY TO THE DSD ENVIRONMENT

- Fourth generation languages have paved the way for the DSD environment. INPUT's report Trends and Opportunities in Fourth Generation Languages:

  - Defined fourth generation languages, their uses and economics, current environment, and impacts.

  - Updated the status of fourth generation languages, the current and projected products, and the major strategic and tactical issues.

  - Examined market trends and user expectations.

  - Provided market forecasts and recommended vendor strategies.

- The importance of fourth generation languages in the successful implementation of information centers and prototyping was emphasized. The acceptance of microcomputers has been accomplished by corresponding acceptance of, and demand for, enhanced fourth generation languages. The use of fourth generation languages on standalone personal computers has, in turn, created the demand for micro-mainframe links.

- The report predicted that as use of fourth generation languages increases, they will be implemented in production systems, including larger systems and transaction-oriented systems. An eventual, and perhaps inevitable role in office automation was also predicted. INPUT forecast that fourth generation languages would be one of the fastest-growing software markets over the next five years.

- This forecast is practically confirmed since fourth generation languages are the key to the DSD environment, and that environment is the most significant trend in information systems. However, to the degree that the DSD environment creates IS problems, and fourth generation languages contribute to the implementation of that environment, fourth generation languages must be analyzed as part of the problem in order to ensure their continued acceptance.

- <u>Trends and Opportunities in Fourth Generation Languages</u> identified two significant IS concerns as far as fourth generation languages are concerned:

  - The performance characteristics of fourth generation languages require substantial, additional hardware resources. INPUT analyzed the installed MIPS per development person after fourth generation language installation and found an average annual growth rate of 125% between 1980 and 1983. In other words, hardware capacity to support development personnel increased by an order of magnitude in three years. This is substantially greater than traditional hardware price-performance improvement.

  - While there is potential for improved systems quality in the DSD environment, INPUT noted three basic user concerns:

    - "The most important attributes of quality systems can be addressed by fourth generation languages. What IS sees is the ability of fourth generation languages to improve system robustness, system flexibility, and data integrity."

- "In contrast, IS is concerned that users will get carried away with these new-found tools and fail to effectively manage data and information."

- "Another concern is users adding more features and functions and actually increasing development and operating costs."

- In order to understand the true effectiveness of tools and aids, it is necessary to analyze all impacts of their use. It is also necessary to understand that true productivity exists at several levels. This requires an overview of the DSD environment.

B. PRODUCTIVITY IN THE DSD ENVIRONMENT

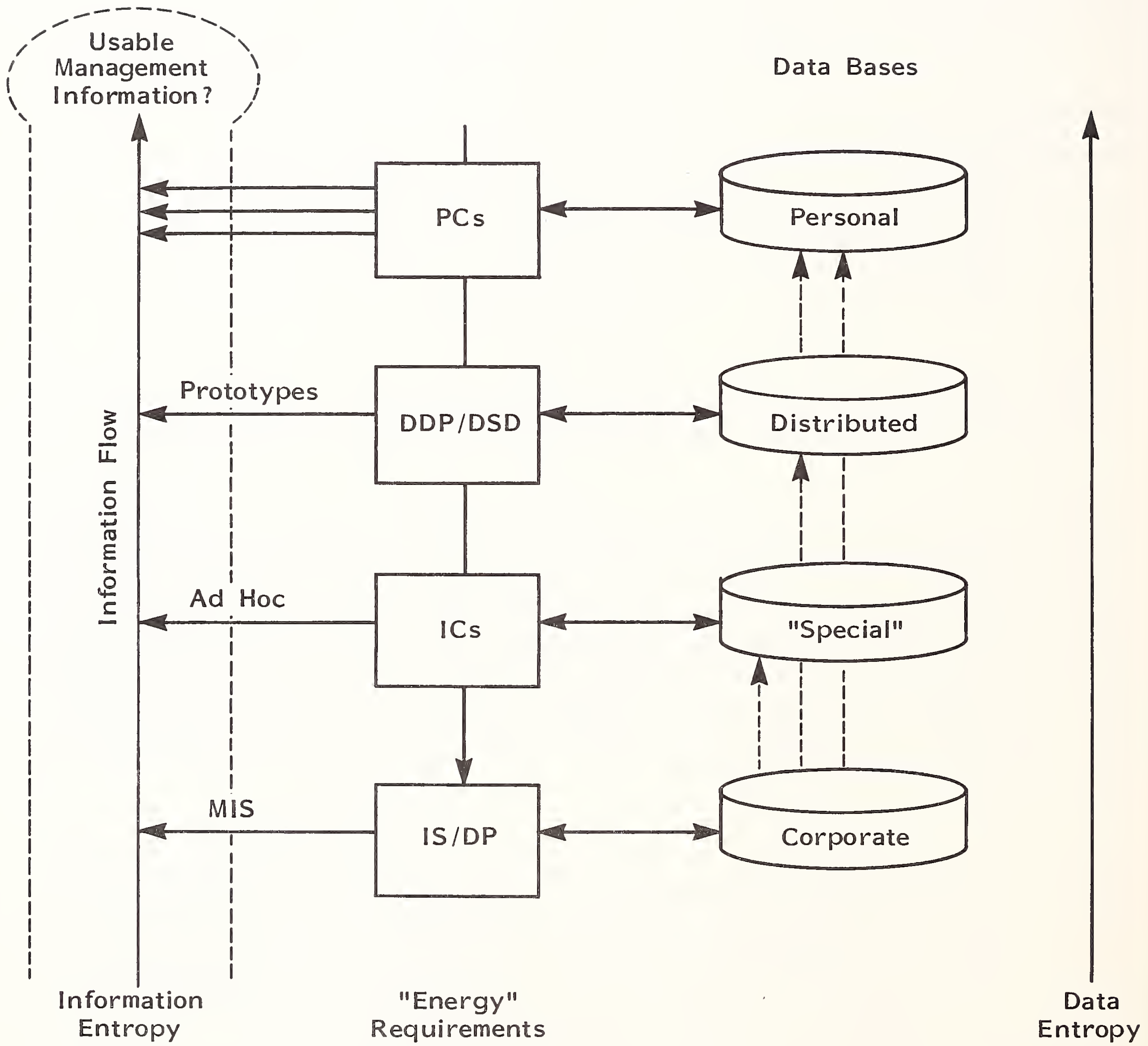
- Despite projections of the extended use of fourth generation languages for major information systems, their primary use in the DSD environment has been for reporting and query from data bases. There is no question that fourth generation languages have been effective for this purpose, and they improve productivity in the sense that they produce large quantities of information more rapidly. The question then becomes one of impact on both quality and cost of information.

- It is possible to have an explosive increase in the quantity of information with a corresponding dramatic decrease in information quality. INPUT uses the term information entropy to designate this natural tendency toward chaos. The DSD environment is a high-entropy environment, shown in Exhibit IV-1.

  - Data entropy increases as data bases are extracted or developed for use in information centers ("special" data bases, perhaps for planning), departmental processing centers (distributed data bases), and personal computers (personal data bases).

EXHIBIT IV-1

ENTROPY IN THE DSD ENVIRONMENT



- The only way to control the natural tendency toward chaos in a high-entropy environment is to apply increasing amounts of "energy" to maintain order. In this case, the energy is computer processing power, plus human energy to explain the meaning and use of data (data base administrators, information center personnel, etc.) To the extent that data bases are distributed, the "energy" requirements placed upon the central facilities will increase.

- Assuming data quality can be maintained at an acceptable level--this is a major assumption, but otherwise quality information would obviously be impossible--there is still no assurance that information quality can be maintained. Every time data are rearranged and/or communicated in the form of information, entropy comes into play again.

  - The fourth generation languages and other "productivity" tools and aids process data and generate different results (information).

  - The people using the data, and tools and aids, use them in a different manner (either through misunderstanding or intentionally.)

  - Data are combined with other data at various levels and definitions become confused or inaccurate.

- As information from these various sources becomes part of the corporate information flow, information entropy increases--regardless of the quality of the underlying data bases.

- The only way to bring any order out of the resulting chaos is to apply more energy. The decision maker must ultimately be the one to select, qualify, and use the information from various sources: the IS depart-

ment, ad hoc reports from planning data bases, output from prototyped systems at various stages of completing special analysis from specific individuals, etc. Otherwise, it is just another exercise in generating additional information and further complicating the decision-making process.

- Therefore, improved productivity in generating more information of lower quality does not necessarily mean improved productivity in terms of meeting corporate objectives. It may be counterproductive in terms of the decision-making processes, with disastrous results for the business plan.

- All of the above is an explanation of what "conflicting reports to management" can mean. There are other conflicts in the DSD environment:

  - There are conflicts between structured programming (and methodologies), principles of top-down design and systems being developed from the bottom up. There is no assurance that they can be easily integrated.

  - Easy access to central data bases is in conflict with the need for protection and security of those data bases.

  - As larger systems are developed with fourth generation languages and other productivity tools and aids in the DSD environment, more functional capability will be required. As more function is added, development systems become more difficult to use.

  - There is conflict between off-loading host mainframes and the demands for additional central processing power generated from departmental processors and intelligent workstations. The balance is far from clear, and in the process of trial and error, massive overloads are going to occur in both directions. (Productivity tools and aids that do not achieve a proper balance are not going to sell.)

- In addition, the parallel GST trends of progressive centralization, progressive integration, progressive differentiation, and progressive mechanization (described in Market Impacts of IBM Software Strategies) are more likely to conflict with each other in the DSD environment. As was pointed out in INPUT's analysis of IBM software strategies, an essential part of IBM's overall strategy is the centralization of GST trends.

- The problems associated with the emerging DSD environment represent opportunities for those who recognize them and so do IBM's attempts to control GST trends. The general market impacts of IBM software strategy must be understood in order to identify promising opportunities. These impacts will be briefly reviewed, but it is recommended that Market Impacts of IBM Software Strategies be referred to for more detailed market analysis.

C. UNDERLYING IBM SOFTWARE STRATEGY

- As mentioned in the introduction to this report, INPUT has defined four IBM strategic software periods, extending past the year 2000. The period between now and 1990 has been called the SNA/DDP period, and during that period IBM will continue to emphasize the highly centralized host control which has characterized SNA from its inception 10 years ago. Subsequent periods and IBM emphasis for each are presented in Exhibit IV-2.

- Recognizing that all of the GST trends progress in parallel, IBM emphasis during any given period determines concentration on particular software categories but does not exclude development in other areas. Keeping that in mind, the strategic periods will be characterized by a focus on particular software areas, shown in Exhibit IV-3.

EXHIBIT IV-2

IBM STRATEGIC SOFTWARE PERIODS

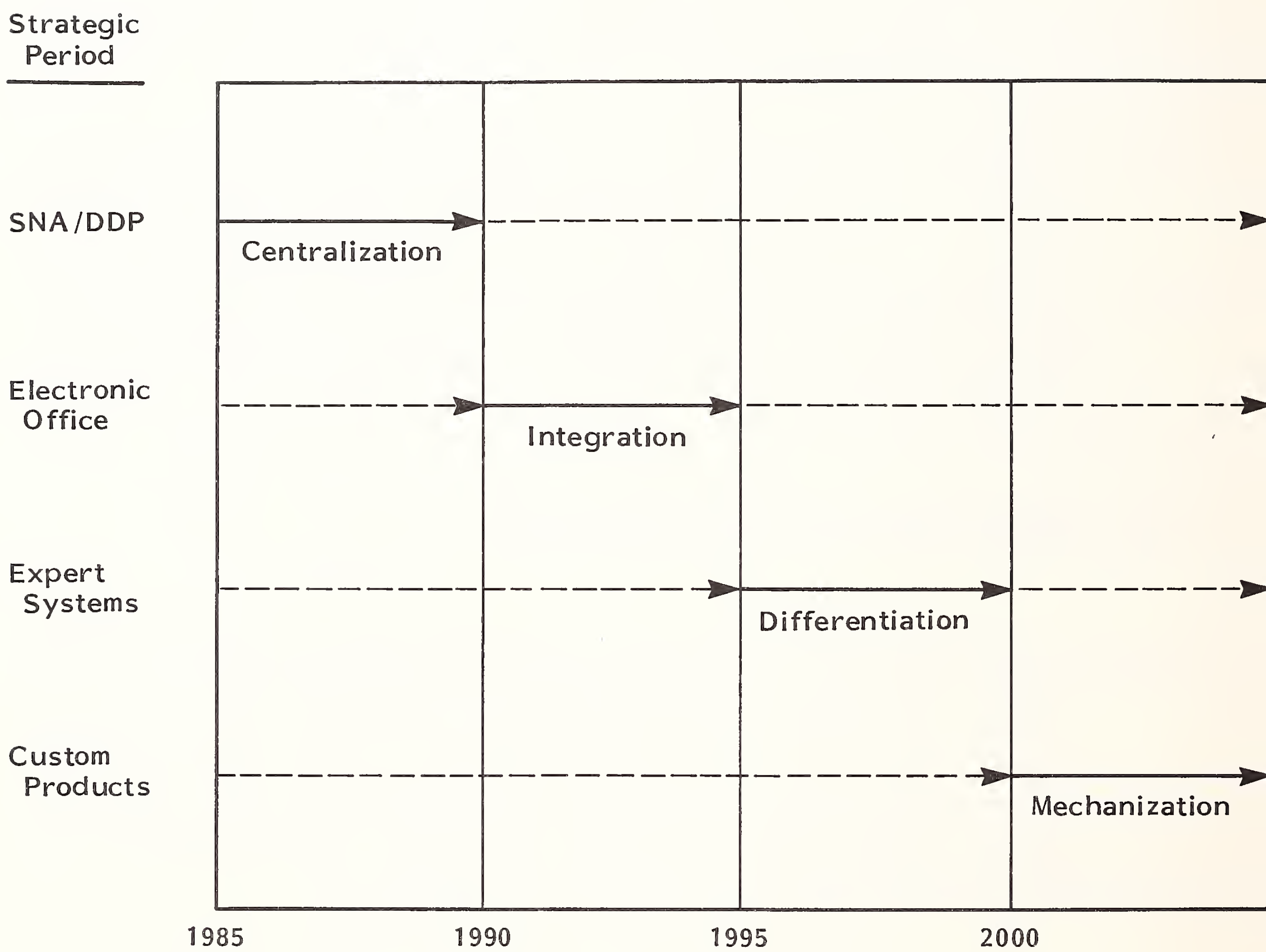
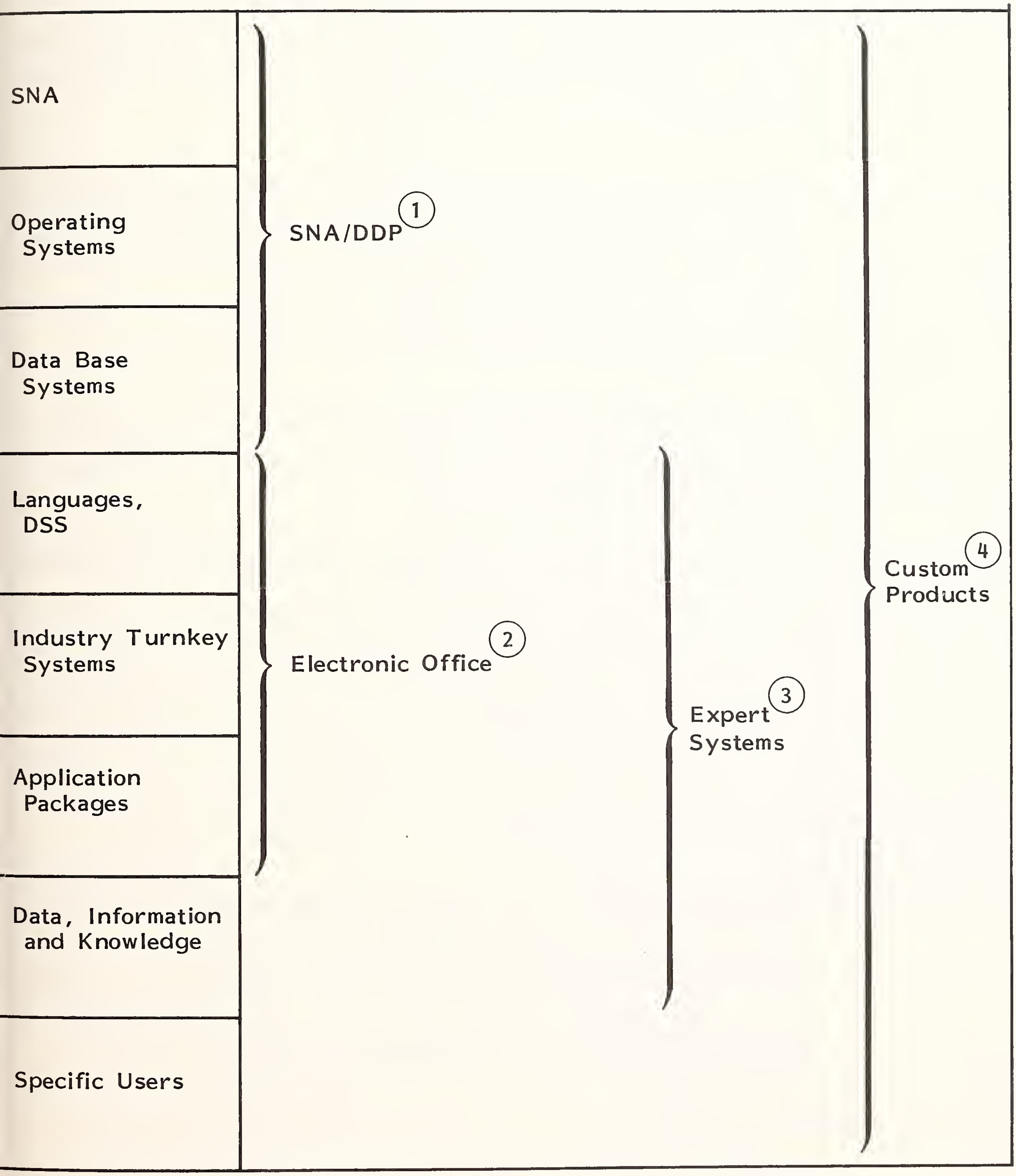


EXHIBIT IV-3

IBM SOFTWARE FOCUS BY STRATEGIC PERIOD



INPUT
MSSP

- During the SNA/DDP period, IBM's emphasis will remain upon centralized control—large host processors and large central data bases will continue to dominate the software strategy.

- During the electronic office period, the emphasis will be upon integrating the fourth, fifth, and sixth levels of software (languages/DSS, industry turnkey systems, and applications packages) into electronic office systems.

- During the expert systems period, the emphasis will be upon the differentiation of the integrated electronic systems of the electronic office period into more specialized software (languages/DSS, industry turnkey systems, and applications packages) combined with level seven (data/information/knowledge) through public information networks.

- During the custom products period, hardware, software and data/information/knowledge will be integrated as custom products and services tailored to the individual.

• Opportunities exist where IBM emphasis deviates from the GST trend dictated by the current state of hardware and software technologies. For example, fourth generation languages represent a substantial opportunity right now because of IBM emphasis upon centralization and concentration on the first three software levels (SNA, operating systems, and data base systems), and expert systems will have a window of opportunity extending into the 1990s. General vendor opportunities during the SNA/DDP period based on specific deviations of IBM emphasis and GST trends are presented in Exhibit IV-4.

  - During the SNA/DDP period, IBM will remain dependent upon highly centralized software, large processors, central data bases and magnetic disk storage to meet its revenue objectives. The challenges to IBM's strategy are important because they also isolate general areas of exposure and therefore opportunities for competitors:

EXHIBIT IV-4

SNA/DISTRIBUTED DATA PROCESSING PERIOD: PROGRESSIVE CENTRALIZATION (1984-1989)

Key: IBM = Predominant IBM Direction
X = GST Direction

SOFTWARE AREAS	Integration	Differentiation	Mechanization	Centralization	VENDOR OPPORTUNITIES
Operating Systems					
Process	IBM	X			Off-Load Host Mainframe (Application)
Storage Management				IBM X	Efficient Storage Management at DASD Level
Protection and Secutity		X		IBM	Define and Address Problems Now
Resource Allocation	X			IBM	Performance Monitors
System Structure			X	IBM	Simplify Through Systems Design
Hardware/Firmware/Software			X	IBM	Data Base Machines, Network Managers, Performance Monitors
Data Base Management	IBM		X		Support Optical Memories, Information Management (New Models for Text, Graphics)
Languages, Decision Support Systems	IBM	X			Differentiate! Languages, Dictionaries
Industry Turnkey Systems	X IBM	IBM	X	IBM	Combine Above and Proceed
Application Packages	IBM	X			Design to Off-Load Mainframe, and with Industry/Professional Specialization
Data/Information/Knowledge		X		IBM	Anticipate and Understand Problems of Entropy & Data/Information/Knowledge

IBM DEPENDENCIES AND CHALLENGES

Dependencies:

1. Magnetic Disk Storage Revenue
2. SNA Hierarchy
3. Big Central Data Bases
4. Big Central Engines
5. Central Software

Challenges:

1. Optical Memories
2. Minicomputer Success in Offloading
3. Entropy
4. Move MIPS on Schedule
5. Performance
6. UNIX Success

- Significant use of optical memories could affect IBM revenues from magnetic storage, revenues essential to IBM's growth during the 1980s.

- Off-loading of mainframes onto minicomputers has been a threat to IBM's highly centralized mainframe strategy for over 10 years, and IBM must continue to control that off-loading--even onto their own minicomputers or microprocessors.

- Unless the entropy of large data bases (and that associated with the DSD environment) is understood, IBM's SNA/DDP strategy runs a substantial risk of exposing customers to major systems failures.

- IBM must deliver the large processors required by their strategy, and this may not be as simple as it has been in the past.

- Hardware/software performance--never an IBM strength--may prove inadequate to support customer strategies--for example, the increased use of fourth generation languages.

- The success of competing operating systems alternatives have had success at various levels in the processing hierarchy. UNIX represents one example:

- There is a paradox in IBM's SNA/DDP strategy: the emphasis upon centralized control appears more appropriate in the DSD environment than it has been in the past, but the complex systems software and its attendant burden may not be up to the task of providing the necessary control.

- INPUT presented a comprehensive analysis of IBM's SNA/DDP strategy in its Large-Scale Systems Directions series of reports during 1984, and reached the conclusion that IBM's mainframes will be used as large data base machines. It is INPUT's opinion that this environment will result in an unprecedented (and unanticipated) demand for MIPS. It is probable that the classic solution of throwing processing power at systems problems is reaching the point of diminishing returns (at least on large mainframes). This is an especially important consideration in the development of productivity tools and aids.

  - As was pointed out previously, the cost of supporting system development personnel (in terms of MIPS) is increasing more rapidly than the processing power per dollar.

  - There is a point at which the cost of hardware and software to support development personnel becomes exhorbitant, just as there is a point at which the cost of the systems developed cannot be economically justified. One expert interviewed during the course of research for this study pointed this out by stating that the increased investment in productivity aids and tools had to be considered in any meaningful measure of productivity.

D. USE AND ACCEPTANCE OF CURRENT TOOLS AND APPROACHES

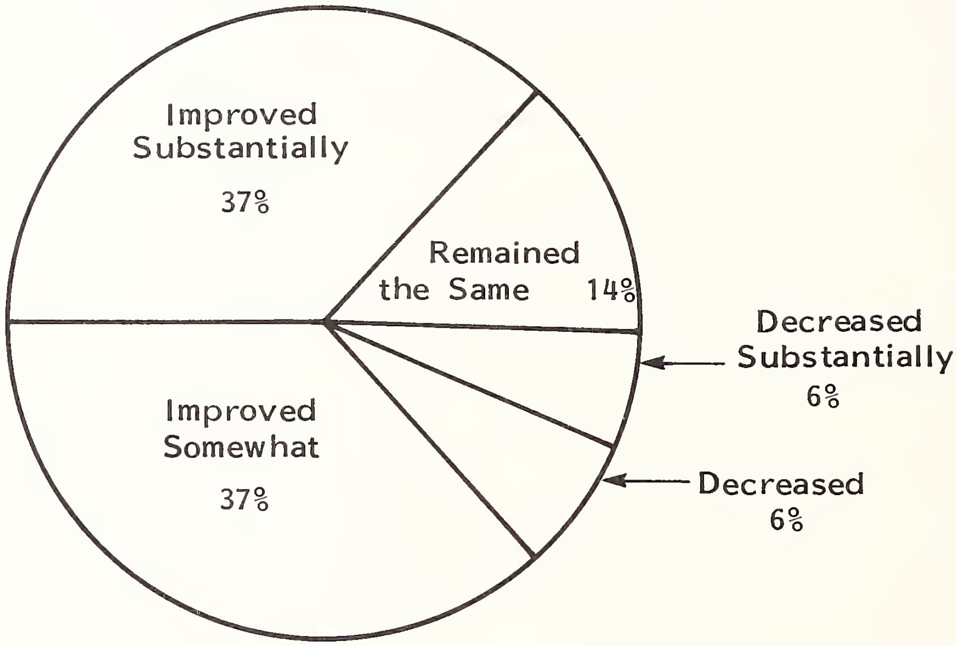
- Respondents were asked how they felt productivity within the IS department had changed since they were interviewed during INPUT's multiclient study in 1980, and what they felt had prompted these changes. The responses are presented in Exhibit IV-5.

  - The changes in productivity since 1980 were reported as follows: 37% stated productivity had improved substantially, 37% stated it had improved "some," 14% said it had remained the same, 6% reported it had decreased, and 6% reported a substantial decrease in productivity.

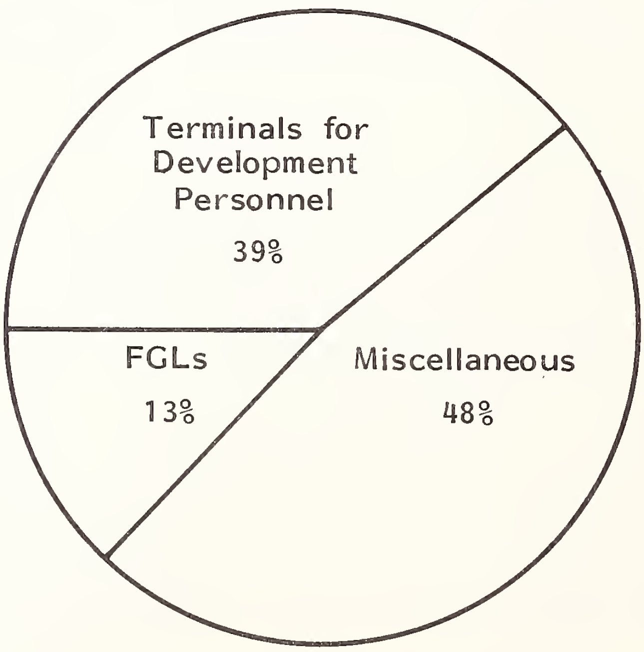
EXHIBIT IV-5

CHANGES IN PRODUCTIVITY SINCE 1980
(Respondents Selected from Multiclient Study)

How Productivity Has Changed



What Contributed to the Change



- The changes which prompted productivity improvement were:

  . Thirty-nine percent attributed the improvement to the installation of terminals to permit interactive development.

  . Thirteen percent reported that the improvement had resulted from the use of fourth generation languages.

  . The remaining 48% of respondents mentioned specific tools or approaches which varied from specific packages such as IBM's Interactive Systems Productivity Facility (ISPF), to "better planning."

- Where productivity decreased, it was attributed primarily to "aging" and overloaded systems, and to such structural changes as reorganization and acquisitions.

● Respondents were also asked about their current use of systems design methodologies and their specific use and evaluation of programming aids.

- Seventy percent of those responding stated they employed a systems design methodology (SDM) and 68% of those using an SDM had developed their own. Eighty-six percent of those using an SDM felt that it had improved the systems development process.

- Seventy-seven percent of those responding stated they emphasized programming aids; and when asked which ones, over fifty products were mentioned, with few products receiving more than a single mention. Seventy-five percent of the respondents using programming aids felt they were effective.

- This simple research revealed the truth of the matter--there is a wide array of effective productivity tools and aids available, and if an approach (such as an SDM) is useful it will be used--even if the users feel they should develop their own. During the course of desk research for this study, a productivity questionnaire developed by Capers Jones was discovered. It consisted of:

  - Twenty major sections and 261 categories under those sections.

  - Under the code development section there were 14 categories:

    . High-speed prototyping.

    . Internal reusable code library.

    . Commercial reusable code tools.

    . Structured coding methods.

    . Applications or program generators.

    . Fourth generation languages.

    . Data base query languages.

    . Standard functional packages.

    . Spreadsheet processors.

    . Information centers.

    . Development centers.

    . Object-oriented languages.

- End-user programming support groups.

- Individual terminals or workstations.

- Twenty years ago, Fred Brooks (of "Mythical Man-Month" fame) stated after becoming Director of Programming Systems for IBM: "I think we have more terms than concepts." The situation has not improved since then. Users are confronted with a formidable array of ill-defined choices.

- As far as the code development market is concerned, there are currently over 100 spreadsheet processors (or integrated analysis systems which contain spreadsheets) available to end users, and it is estimated that 15 to 20 new products per year are being announced in the fourth generation language category alone. Though the market is chaotic, the potential customers remain undaunted in their search for a solution to the productivity problem.

- IS directors were asked whether they were more (or less) receptive to possible alternative productivity approaches than they had been in 1980. The results are presented in Exhibit IV-6.

  - The increased acceptance of fourth generation languages is clear: 79% of respondents are more receptive to their use than they were in 1980, and no respondent was less receptive. It is INPUT's opinion that the DSD environment is fueling this increased acceptance of, and demand for, fourth generation languages.

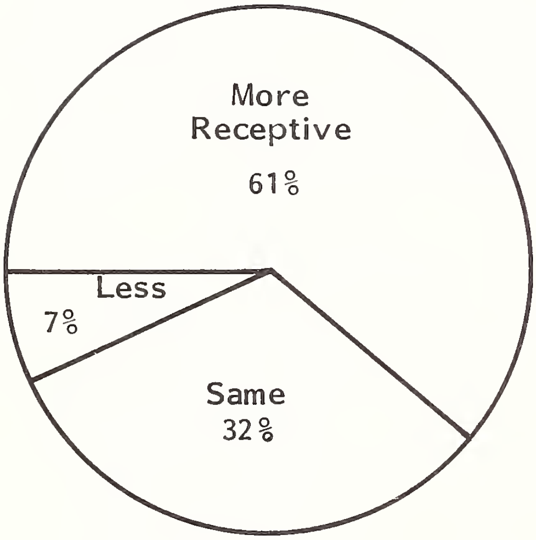
  - There is also an increased acceptance of applications packages (61% of respondents are more receptive) as an alternative to in-house development.

EXHIBIT IV-6

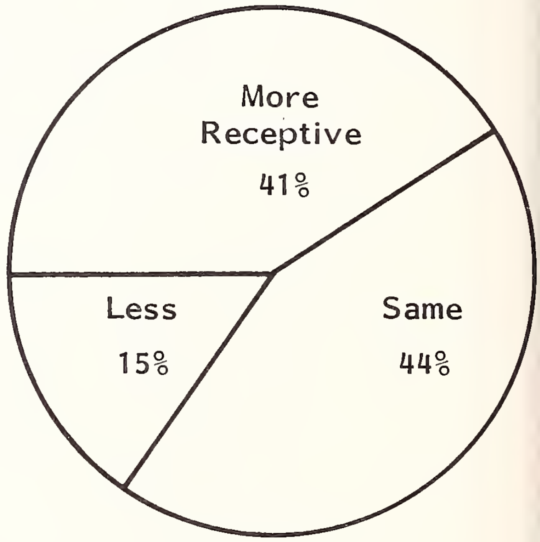
CURRENT ATTITUDES TOWARD ALTERNATIVE PRODUCTIVITY APPROACHES

(Compared to 1980)

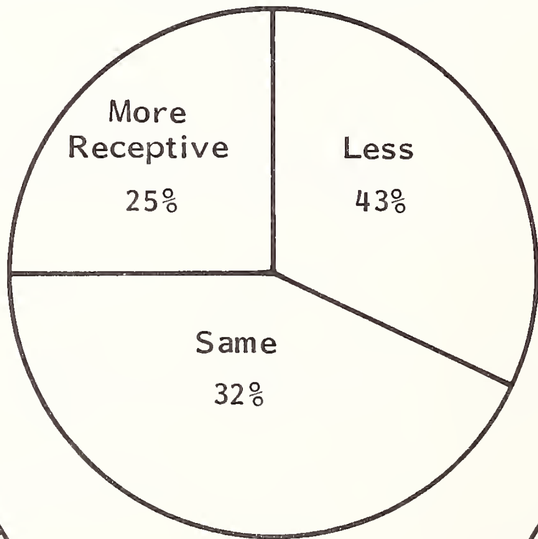
Applications Packages



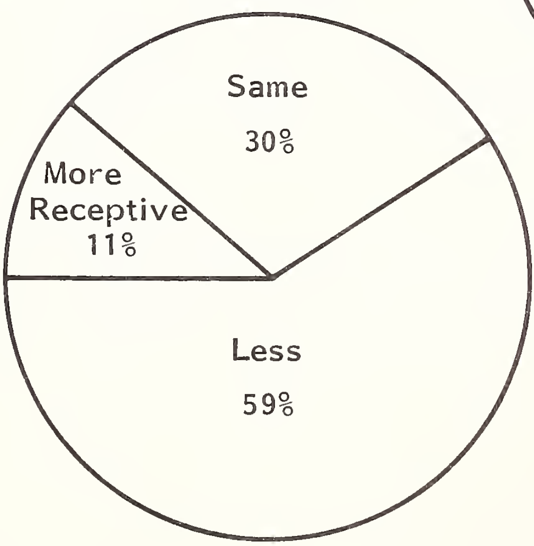
Industry Turnkey Systems



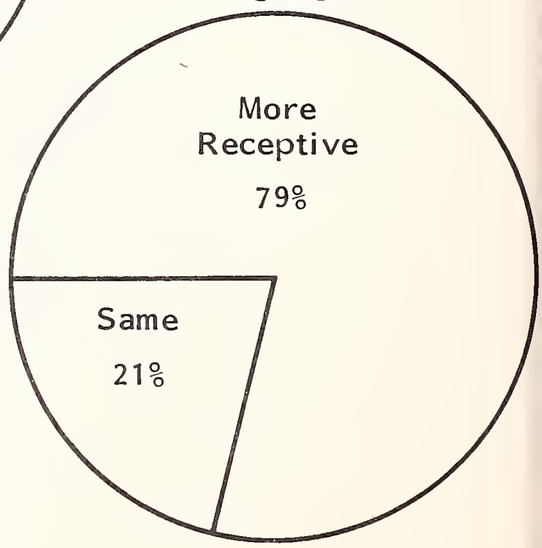
Outside Systems and Programming Assistance



Outside Processing Services



Fourth Generation Languages



- Concerning industry turnkey systems, 41% of respondents are more receptive, as opposed to only 15% being less receptive.

- Concerning outside systems and programming assistance, the balance shifts--with 43% of respondents being less receptive to such services and only 25% being more receptive.

- As anticipated, outside processing services are received with substantially less favor. Fifty-nine percent of respondents stated they were less receptive than they had been in 1980, and only 11% stated they were more receptive.

- This question was not designed to hammer at a dead issue. It is highly probable that some categories of expert systems will be delivered as a remote service from proprietary knowledge bases and inference engines.

E. I.S. MANAGEMENT'S DILEMMA SUMMARIZED

- Microprocessor technology combined with user friendly software has created the DSD environment. In this environment, it is possible to see tangible results much more rapidly than through the conventional systems development process. End users become involved in the systems development process with the following results:

  - They cannot understand why it takes so long for the IS department to develop systems.

  - They become more "expert" than the IS department in some of the new technology.

- Additional demands are made upon the IS department to support and employ the new hardware/software systems.

- There is an astonishing array of hardware/software "solutions" available in the DSD environment, but IS departments are not necessarily expert (or even literate) in the use of these tools, aids and/or technologies. The natural tendency is to become defensive (the COBOL vs. fourth generation language controversy is a good example) and to seek direction and support from its traditional ally—IBM.

- Unfortunately for the IS department, IBM is not only offering various (and conflicting) solutions of its own, but is also endorsing the products of other vendors who would formerly have been considered competitors. This endorsement can take many forms, ranging from outright acquisition (ROLM) and substantial investment (INTEL) to marketing agreements (INTELLECT from Artificial Intelligence, Inc.).

- It all adds up to substantial confusion as to exactly what IBM is doing, or will do in the future. This affects not only competitors but also customers who may be looking for some direction and have learned over the years to trust IBM. In the DSD environment more than trust is required—IBM seems to be demanding blind faith.

- IBM's reputation is such that many companies (or at least their IS departments) are willing to believe that anything IBM endorses will "turn out all right" because IBM "will make it work". While this belief is not entirely unjustified, some of the more informed IS managers are becoming concerned about questions which IBM has never been especially interested in solving for their customers. Specifically:

  - Whether the cost of "making it work" is worth it.

- Whether the necessary data to support the hardware/software systems is available, or of sufficient quality, to warrant the investment.

- Whether management will consider the investment in computer hardware/software systems to be justified based on the quality of the information produced.

- However, most IS management is so busy reacting to the new DSD environment that they have not had time to consider even the tools and aids which might be useful in making the IS department more effective, much less the quality of the systems they are so busy implementing; and now IS departments have a vague sense of impending doom.

V NEW OR IMPROVED TOOLS REQUIRED

V NEW OR IMPROVED TOOLS REQUIRED

A. RESEARCH CONCLUSIONS

- Most IS managers responsible for supporting the DSD environment do not have sufficient knowledge or resources to evaluate the tools, aids, and approaches to productivity improvement currently associated with that environment. When asked about tools, aids, and approaches that might facilitate the implementation of the DSD environment, very little specific direction was evident from the responses, as shown in Exhibit V-1.

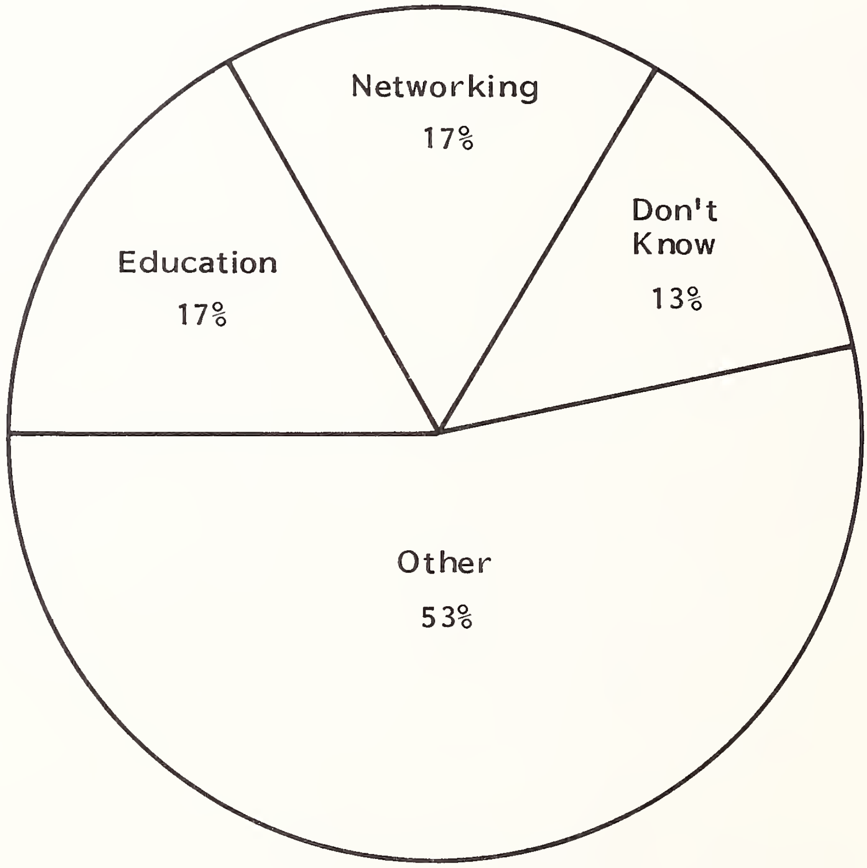
  - Education included everything from better product education by vendors to general user education on data processing concepts and problems.

  - Networking elicited a similarly vague response, except that micro-mainframe links were mentioned frequently; however, neither IS management nor vendors have a very clear concept of what is meant by a micro-mainframe link.

  - The answers falling into the "other" category varied from the very specific (RACF and SAS Graphics) to the extremely vague ("better prototyping" and "decision support software").

EXHIBIT V-1

TOOLS, AIDS, AND APPROACHES TO FACILITATE DSD
(IS Management Respondents)



- The anticipated problems associated with the DSD environment had been identified in the interview prior to the respondents being asked for their recommendations of tools, aids and approaches to control the DSD environment. The responses indicate that very little thought has been given to solutions to the problems which were so easily identified, as shown in Exhibit V-2.

  - Twenty percent of the respondents failed to answer the question at all, and an additional 17% specifically stated they had not given the matter any thought or didn't know what was required.

  - The only "solution" that was suggested by a significant number of the interviewers (17%) was to limit data base access. This solution has high potential for being in direct conflict with the primary purpose of micro-mainframe links, which is to provide access to central data bases. In fact, one of the experts interviewed cited a particular example where a major bank encouraged distributed processing (and distributed systems development) with the following results:

    - The various organizational entities within the bank soon recognized that data/information represented power.

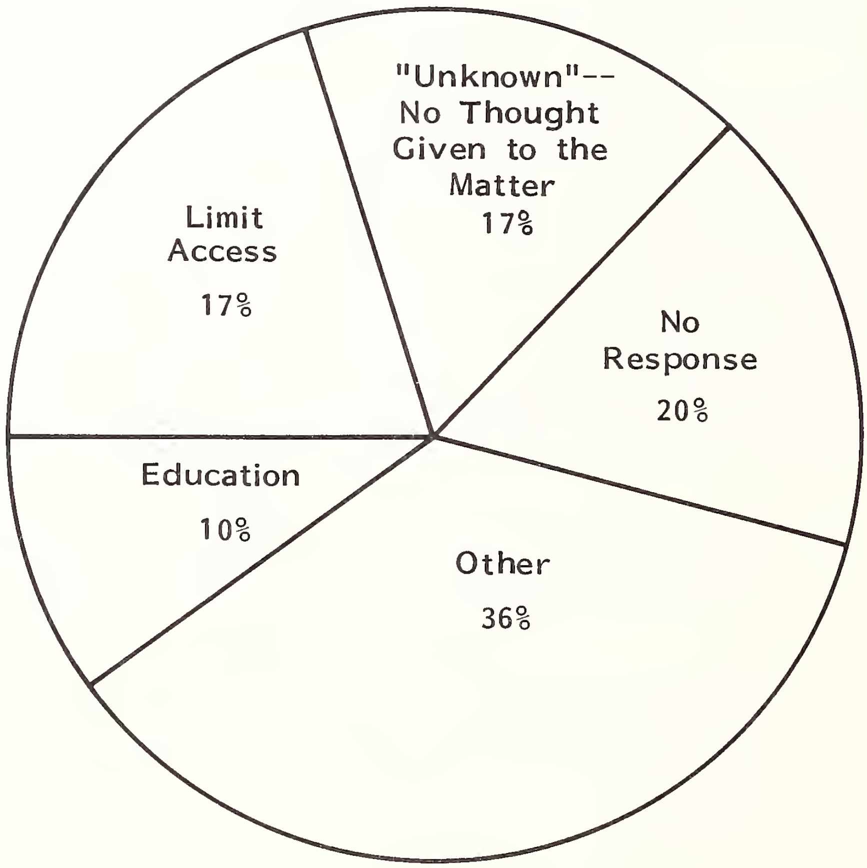
    - Therefore each organization attempted to acquire data from the others but none wanted to provide access to their own data bases.

    - The result was an environment in which a number of warring, data-based fiefdoms competed against each other for managements attention, with disastrous results for the institution (and eventual return to a centralized IS operation).

  - There is an area of agreement in the responses, in that education is mentioned as being necessary for both promoting and controlling the DSD environment (17% mentioned education for promotion and 10% for

EXHIBIT V-2

TOOLS, AIDS, AND APPROACHES TO CONTROL DSD
(IS Management)



control). It is assumed that these responses reflect a general feeling that if the limitations of the tools, aids and approaches being employed in implementing the DSD environment are understood, the problems will not develop. It is INPUT's opinion that this is not necessarily so because the problems are not currently understood. Even with intelligent implementation, unpleasant surprises will arise unless the threats to information quality are recognized.

- The "other" category contained an assortment of requirements such as: standards, capacity planning, data dictionary, back-up facility for data integrity, and structured project management.

• When asked whether they had heard about any new tools, aids and approaches which seemed promising for the DSD environment, 60% of the IS respondents stated "no", 17% did not respond, 7% stated they hadn't looked, 7% mentioned IBM products (RACF and DB2), and the remainder (8%) mentioned several other specific packages. This general lack of responsiveness to an extremely dynamic market can be interpreted in several ways:

  - Anything "new" runs a high risk of being lost among the abundance of tools, aids, and approaches already available.

  - IS management does not have the time and/or ability to analyze the tools, aids and approaches that might improve productivity in their organizations.

  - Nothing new is really being announced; all of the activity represents a repackaging of past solutions with new terminology.

  - It is probable that all of the above are at least partially true, and the result is chaos in the marketplace. One thing is certain in such an environment--there is no certainty that those who build a better mousetrap will have anyone beating a path to their door.

- Vendors and experts generally paralleled IS management in their recognition of the potential problems associated with the DSD environment. However, apart from the particular approach that each took to solving the productivity problem, they generally chose to ignore their contribution to the overall problem of systems quality. Users of the tools, aids, and approaches were expected to make intelligent use of the products and were handed responsibility for understanding (and correcting) any impacts on systems quality. Although this general attitude is understandable and even justified, INPUT believes that a substantial opportunity exists for those vendors that are willing to address quality problems directly.

- In summary, the current emphasis upon end-user involvement in the systems development process--without sufficient attention to quality--has created an environment that IS management recognizes as presenting some serious problems. However:

  - These potential problems are not very well understood, and are generally being ignored in the rush to implement the DSD environment.

  - Current productivity tools are available in abundance, but may result in the rapid development of systems of such poor quality that they will actually be counterproductive.

  - The need to complement and supplement current productivity tools, aids, and approaches with facilities to maintain and improve information quality is generally recognized.

  - IS management is currently unable to define specifically their requirements for features and facilities which would be of value to them in controlling the DSD environment.

- Classic market research techniques are of little value in defining market requirements and opportunities in an environment that is as complex as that described in this study.

- New methods of market analysis and forecasting are required if the substantial opportunities presented by the DSD environment are to be exploited. A general framework for both market analysis and forecasting has been presented by INPUT in Market Impacts of IBM Software Strategies, 1984.

B. WHAT IS AN INFORMATION SYSTEM?

- It is important to understand exactly what an information system is--and the current status of the hardware/software technology needed to support such systems--before determining how such systems can be most effectively implemented.

- The first thing to recognize is that information systems existed before computers, and consist of only five primary processes: input, communications, calculations/manipulation (processing), storage, and output. The most important thing happening in information systems development is the change from paper to electronic media, as shown in Exhibit V-3.

  - The historical information is presented only for perspective. The mechanical and electromechanical devices developed in the 19th century (cash registers, adding machines, punch card equipment, and typewriters) have been severely impacted by electronic counterparts. However, the telephone and telegraph remain virtually unchanged in terms of function (despite electronic implementations).

EXHIBIT V-3

THE FUNDAMENTAL CHANGES IN I.S. MEDIA

	INPUT	COMMUNI-CATIONS	CALCULA-TION/MANIP-ULATION	STORAGE	OUTPUT
Predominant Media Prior to 1800	Paper	Paper	Paper	Paper	Paper
Productivity Improvement 1800-1900	Cash Register (1888)	Telegraph (1837) Telephone (1876)	Adding Machine (1888) Punch Card Equipment (1896)		Typewriter (1867)
Predominent Media 1900-1950	Paper Transactions, Books,Reports Etc.	Paper Corespon-dence (Mail)	Paper (Including Punch Cards, Mathematical Tables, Etc.)	Paper File Cabinets, Libraries	Paper Memos, Reports, Letters
The Computer "Revolution" 1950-Present	Terminals, Intelligent Work-stations	Satellite, Broadband, LANs, Etc.	Computers	Disk and Tape Storage, Micro Graphics	Copiers, Word Processors, Printers, CRTs
Predominant Media	Paper	Paper	Electronic	Paper	Paper
Projected 1990s "Electronic Offices"	Electronic	Electronic	Electronic	Electronic	Electronic

- However, at this point, only the calculation/manipulation process is currently electronic- rather than paper-oriented. Very few paper and pencil calculations are performed, and mathematical tables are effectively obsolete.

- Other processes remain predominantly paper-oriented.

    . Paper reports and records of transactions remain the primary source of entry into both information flow and computer data bases despite the development of some major operational systems that capture data at its source--for example, airlines reservation systems and a limited subset of financial transactions, such as ATMs.

    . Paper remains the primary communications medium between individuals and systems, including processes within systems--output to input, and output to storage, etc.

    . Despite rapidly increasing use of magnetic storage and micrographic storage, most information resides in paper libraries and file cabinets, and the volume of paper documents requiring storage (or disposal) continues to grow at an alarming rate.

    . As far as output is concerned, it is not inaccurate to state that the implementation of computer technology and office automation products has increased the amount of paper output astronomically creating the current problems in productivity among white-collar workers.

- It is therefore of extreme significance that technology to control this paper glut is becoming available. It is INPUT's opinion, that the availability of cheap, optical storage is the key to a reduction in paper for information systems, as opposed to paperless offices which will require

reorientation of the entire work force. (It is beyond the scope of this study to pursue the development of optical memories, but readers of this report are encouraged to review Impact of Upcoming Optical Memory Systems, INPUT, April 1983.)

- The important conclusion is that the substitution of electronic for paper media (in the fundamental information system processes) represents the primary design point for the systems that will be developed during the late 1980s and 1990s. This has many ramifications for IS management and thus for vendors.

  - Understanding and becoming involved in current paper-based information systems and procedures becomes imperative for IS management.

  - The quality impacts of the DSD environment on information flow (as depicted in Exhibit IV-1) become increasingly important as the replacement of paper-based systems and procedures becomes imminent and IS management faces its responsibility in facilitating this replacement. When conflicting paper reports must be replaced, they must be debugged and integrated, and there isn't any question about who was responsible for letting it happen, nor about who will straighten out the mess.

  - The tools, aids, and approaches IS management is going to need will be apparent only after current information flow is clearly understood and the impact of new hardware/software technology is fully appreciated.

- The DSD environment is designed to improve productivity by providing quick answers to specific requests for information, typically in ad hoc reporting, special analyses, and "what if" queries. To the degree that the quality of information systems is impacted by this environment, the most likely questions from management will probably change to "why?":

- Why don't these reports agree?

- Why does this information cost so much?

- Why is this information wrong?

- Why isn't the data base any good?

- Why do we need a bigger computer?

- Why do we get different answers to the same question?

- These questions will be substantially more difficult to answer than were the original requests for information, and they will have a severe impact on both the productivity and the credibility of the IS function.

- Therefore, while IS management may not be able to specify the tools, aids and approaches they require in order to improve productivity, it is possible to formulate requirements by anticipating the hardware/software technological environment, the types of information systems which will be possible, and the problems which will be inherent in the development of these systems.

C. PRODUCTIVITY TOOLS AND AIDS IN THE DSD ENVIRONMENT

- It is beyond the scope of this study to specify new tools and aids for productivity in detail. Some may appear to be currently available; others may be merely a research direction to determine the best solution to a problem. However, they are all directed toward restoring commitment to quality to its proper place in the productivity pyramid. In addition, these tools and aids have two additional attractions:

- They are especially well-suited for providing not only control in the DSD environment, but also necessary data and information to develop systems requirements and specifications for the electronic office (office automation system).

- They will establish the foundation for extending decision support systems to expert systems (where quality must be fundamental) by providing at least a preliminary connection between data/information bases and the decision-making process. By tracking data/information flow and associating it with use in decision making, potential for expert systems may be identified and at least some of the inputs to future knowledge bases will be qualified.

    . The developers of expert systems have already determined that they must be prepared to answer "why?" questions.

    . Understanding what any system is doing is fundamental to quality control and improvement, and expert systems will require rigid and continuing quality control.

I. INFORMATION BASE MANAGEMENT SYSTEMS (IBMS)

- INPUT's Information Systems Program companion to this report, New Opportunities for Software Productivity, identified the need for an "expanded data/information dictionary capability" as an aid to productivity improvement. Actually, as the requirements became more clearly understood, it was apparent that, even in its simplest form, the system required was much more comprehensive than any extension of a current data dictionary.

- For lack of a better term, INPUT calls this system an Information Base Management System (IBMS). Essentially, it is a central locater of information sources and can most easily be described as a supervisory system for other data/information dictionaries and directories.

- The complexity of the system becomes apparent as soon as it is recognized that human beings and organizations are information sources, as are data bases, libraries and file cabinets. A rough diagram reveals the comprehensive nature of such a system, as shown in Exhibit V-4.

    - In its simplest implementation, the IBMS could merely provide centrol access to various catalogues, directories, and dictionaries.

    - Search and retrieval capability against these catalogues, directories, and dictionaries could be enhanced by prompting, to refine inquiries (and reduce information references).

    - More detailed vertical penetration would permit rapid browsing. For example, abstracts and descriptions could be prescanned and surrogate data bases developed (key words are extracted) for fast searching. The bottom of the vertical chains would always provide specific access information and detailed descriptions and definitions of what is being accessed. This could be instructive in how to use a data base system or a telephone number of a specific person.

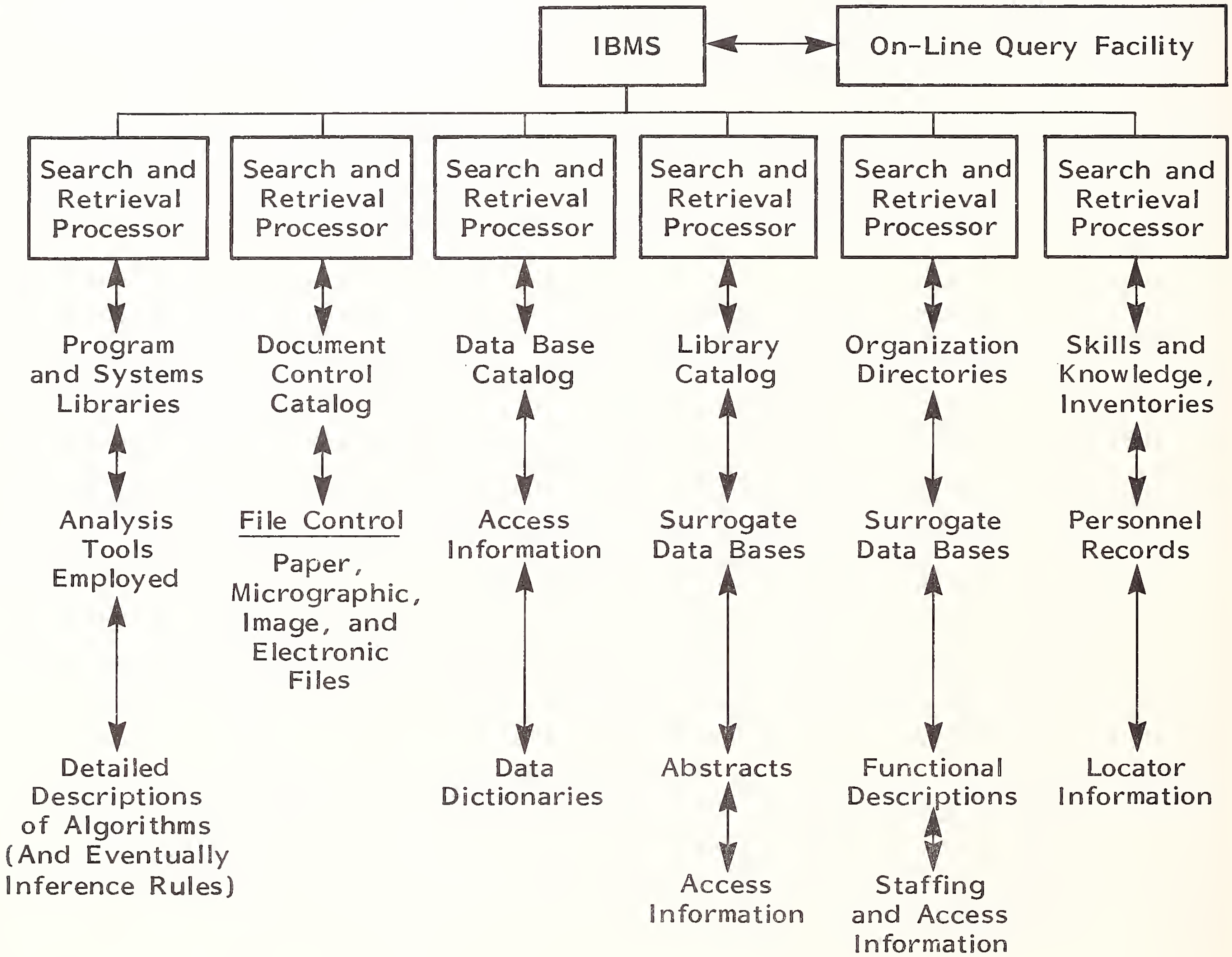
    - In addition, the software programs used and/or available to develop information from data would be available.

- Ultimately, the ability to associate and qualify the various information sources in a meaningful domain for research and analysis on a specific project (subject) would be the goal of IBMS. This would have the following ramifications:

    - It would be an "expert system" in the sense that it would not search based on specified algorithms and would present a preliminary knowledge base rather than a list of information sources. (This significance of expert systems will be presented in INPUT's report on <u>Artificial Intelligence and Expert Systems</u>.)

EXHIBIT V-4

AN INFORMATION BASE MANAGEMENT SYSTEM
(IBMS)



- The ability to locate, qualify, and associate various information sources during the requirements phase of the systems life cycle would be an extremely effective productivity tool. Specifically:

  . Redundant information systems would not be developed where adequate information already existed.

  . Software systems unsupported by necessary data/information could be avoided.

- Indeed, in certain decision support situations, the query might provide all necessary information.

- Since the quality of data and information is fundamental to systems quality, the IBMS is a necessary quality control mechanism and should be viewed as a shared resource among the IS department, information centers, and end users.

• The development of an efficient IBMS obviously requires a great deal of effort (and perhaps invention) on the part of systems software developers and information specialists (librarians, data base administrators, etc.) However, it has the advantage of being modular and lends itself to phased implementation. Essentially, it is a mechanism to facilitate integration of existing systems (manual and computer-based).

2. DOCUMENT CONTROL SYSTEMS (DOCS)

• Perhaps the most important missing subsystem under the IBMS is a comprehensive document control system (DOCS). Most organizations have automated portions of the process (mailing lists, classified documents, engineering drawings, etc.), but IS departments have traditionally ignored paper-based

systems and procedures until there are demands for computer-based systems. In addition, the paper mill mentality of data processing personnel has contributed to the problem by facilitating the production of paper reports.

- Information entropy in the DSD environment as identified in this report, (see Exhibit IV-1) and the potential for controlling and/or eliminating paper documents in the electronic office strategic period (see <u>Market Impact of IBM Software Strategies</u>) both offer compelling reasons for the development of a comprehensive DOCS.

- The DOCS should provide for the following:

  - Distribution control, perhaps enforced by requiring all forwarding of documents to be handled by a central directory.

  - Classification, not only for security purposes, but for information quality. Classification could be

    - Produced from a certified central data base by production programs.

    - Produced from a certified central data base by prototype system.

    - Produced from a control data base extract by a specific personal computer software package.

    - Produced from a personal or organizational data base by registered program (tested and installed centrally).

    - Produced from a personal data base by special program.

- The variety of categories is enormous and must be tailored to the organization's requirements, but the restriction of classification provides a means of reducing information entropy.

- Footnoting, in order to associate the specific document with other information branches under the IBMS. This could be selectively printed on the document or available upon request.

- Retention information pertaining to the storage, retrieval, and disposal of the document (either paper or electronic).

- The DOCS is essential as more documents become stored on magnetic and/or optical media, but it also should provide the means for data and information flow analysis, which is so essential in the DSD environment.

- The work required to implement such a system is considerable, and the need for imaginative tools and aids is limited only by the creativity of those addressing the problem. Once the DOCS structure has been established, the need for more refined analysis tools and control mechanisms will become apparent.

3. DATA FLOW MONITORS (DFM)

- At present there is a tendency to download data to microprocessors in report format, and it is possible that with a fully developed DOCS, data flow could be monitored by merely associating the document with the data base branch of IBMS (see Exhibit V-4). However, since data will be distributed both through reports and through direct requests for data transfer, and it is anticipated that some of these requests will be "unreasonable."

- Data flow among systems and intelligent workstations must be monitored to determine performance (and cost) impact on the communication network, host systems, processing nodes, and intelligent workstations. A host-controlled

data flow monitor (DFM) will be essential if a proper distribution of both data and processing is to be maintained.

- DFM becomes activated at the point where data/information is to be transferred from or among systems (host or development processors) and/or intelligent workstations--after the data/information has been located, using IBMS. However, since the request for location information must be monitored, DFM treats IBMS as simply another query system to be monitored, as shown in Exhibit V-5.

- The purpose of the DFM is to analyze authorized requests for data/information--protection and security will be isolated in a separate system--either upon request or in anticipation of network performance problems, and to accumulate data/information flow statistics for analysis. Implementation of a DFM could vary from the very simple to the extremely complex.

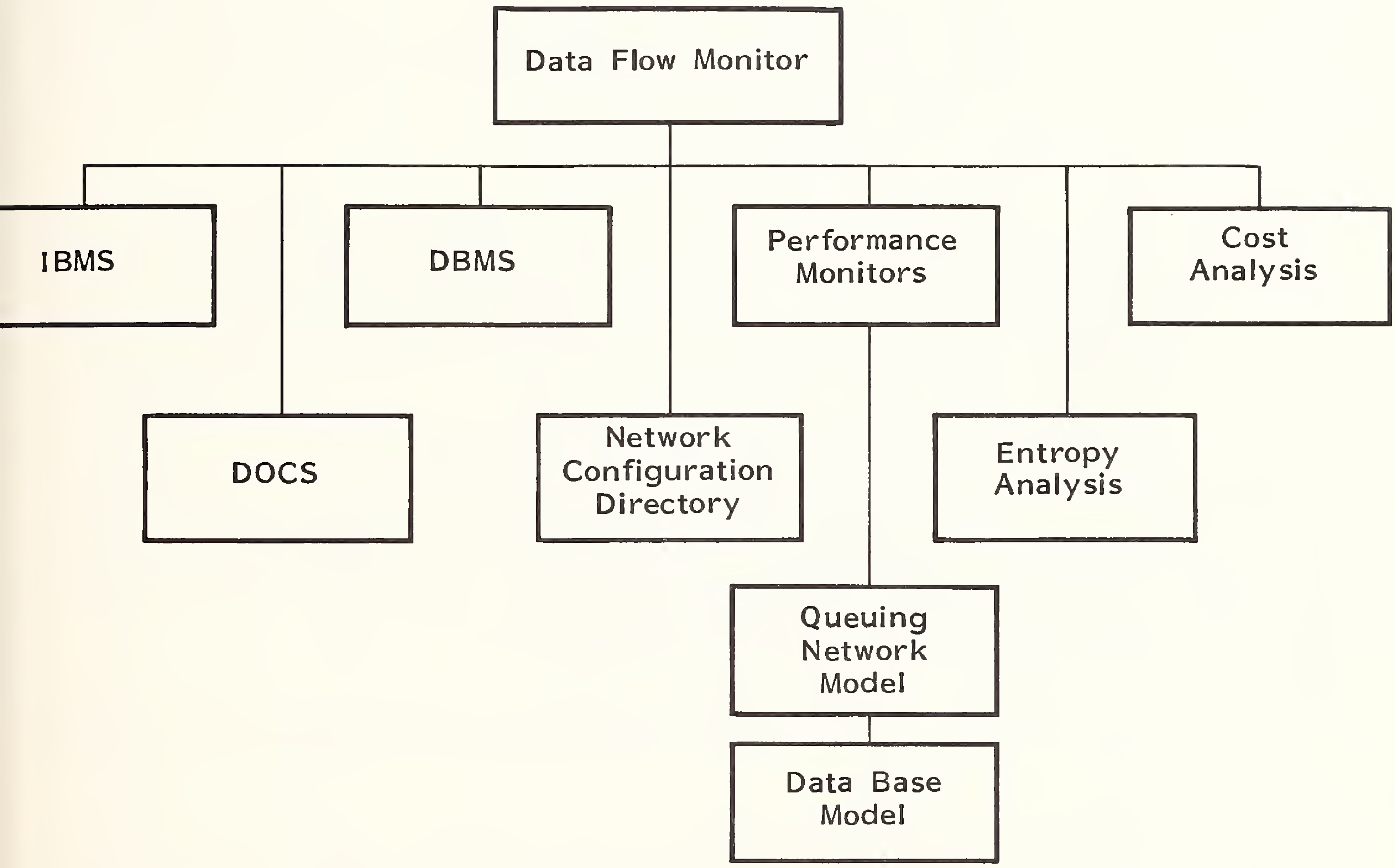
    - Simple decision rules could screen out impossible requests. For example, you don't send a gigabyte data base to an intelligent workstation, even if the requester is authorized to access the entire data base, because it might be physically impossible.

    - Either the central processing required or the communications capacity required might be considered cause to reject a request based on anticipated impact. For example, performing a JOIN on relational tables beyond a certain size might be prohibited (in fact, building relational tables beyond a certain size might be prohibited), or single requests for data/information might be screened based on the capacity of the communications link.

    - A further level of refinement might anticipate an error (or naive request) on the part of the requester based on the volume or cost of the data/information requested.

EXHIBIT V-5

A DATA FLOW MONITOR
(DFM)



- The statistics gathered by DFM are for use in both refining the protection/security system and in permitting management analysis for information flow and organizational studies. The type of statistics gathered could be geared to various levels, from micro-organizational levels down to the individual.

- In addition, the statistics would be essential for network planning and control. The network configuration directory is really a model of the total hardware/software network, which is subject to operational analysis for purposes of reconfiguration.

• The purpose of the DFM is to ensure that unworkable (or unnecessary) systems do not evolve in the DSD environment. Conventional hardware and software performance monitors and accounting systems will be essential in implementing DFM, but new tools are also necessary. Some tools are beginning to emerge in work which is being done in artificial intelligence, and some are already available in the more pragmatic work which has been done in operations research. However, there is no question that creative adaptation and even invention are required for quality control in the DSD environment, which truly represents both challenge and opportunity.

4. OPERATIONS RESEARCH AND ARTIFICIAL INTELLIGENCE (O.R. AND A.I.)

• There is a strange connection between operations research, artificial intelligence, and security/protection that can be traced back to Great Britain during World War II, and specifically to Alan Turing.

  - The famous Turing test is still used as a measure of machine intelligence and becomes especially appropriate in complex computer/communications environments.

- The term "operations research" was developed in the course of fighting German U-boats in the North Atlantic. Turing was a key figure in developing the hardware necessary to break the German "Enigma" codes and thus "read the mail" of the German communications network. Nowhere was this more effective than in combatting German naval operations.

- Since World War II, operations research has taken a rather pragmatic approach to many problems associated with industrial engineering; artificial intelligence has become an academic research area, and security/protection has become a matter of substantial concern associated with both private and public data bases. It is only in the current environment of emerging expert systems that the connection between operations research and artificial intelligence is being established (or at least considered). Specifically:

  - The break between algorithmic and inference-based solutions to complex problems has resulted in an "either/or" mentality, which appears to be reaching a point at which it could be detrimental to both disciplines. The better-informed practitioners (on both sides) are beginning to understand the need for communication between OR and AI, but it is probable that the rift will result in serious problems with some early expert systems.

  - The important point is that elaborate expert systems of questionable value may be developed where the proper application of existing tools of operations research would provide better solutions; and/or, the tools of operations research will freeze "solutions" to problems which could benefit from the analysis and flexibility inherent in knowledge-based (and expert) systems.

  - It appears that even DFM will require the proper application of tools from both OR and AI; and in fact, application of OR and AI tools may in themselves require a DFM.

- There has been a gradual (and sometimes reluctant) recognition that the work done by OR researchers on queuing networks has value for resource allocation (performance monitoring) of both operating systems and computer/communications networks. One of the problems of acceptance was that the example that OR researchers used for queuing networks was a highway with multiple on- and off-ramps, and the problem of a CPU with multiple I/O devices was not readily apparent to computer scientists. Currently, application of queuing network theory to local area networks (LANs) is becoming apparent.

- A general analysis of queuing networks is contained in What Can Be Automated?--The Computer Science and Engineering Research Study, MIT Press, 1980, and is significant for the OR/AI interfacing problems that INPUT anticipates.

  - When networks are used for predicting device utilization and throughputs, the error rate hardly ever exceeds 5%. When network models are used to predict queue length and waiting time, errors often occur at a rate of less than 25%. But networks are, of course, less reliable predictors of queue length and waiting time.

  - It seems that queuing theory depends on the assumption of exponential distribution of time and service in each system device. This seldom occurs in actuality, though.

  - It is better, therefore, to use a structurally accurate model that has only approximate distribution of service and time. In sum, error is interjected less often by service-time distribution than by approximations in model structure.

  - It is INPUT's opinion that under any circumstances, the application of queuing network theory can make a substantial contribution to many of the functions associated with the DFM, and it has been incorporated in the monitor's structure (see Exhibit V-5).

- On the other hand, problems of entropy in both data and information are not clearly understood (see Exhibit IV-1), except to state that:

    - Entropy is higher on large, flexible data bases, and it is assumed that more processing power (energy) is required to maintain quality. For example, it is apparent that a large data base employing the relational model has high entropy.

    - Rearrangement of the same data in many different formats (distribution of data bases) increases entropy.

    - Distribution of the same information in many forms increases entropy.

    - The more nodes (whether hardware, software, or human) that data/information flow through in a communications network, the higher the entropy of the network.

    - To the best of our knowledge, effective models to measure data/information entropy do not exist. There is a need for analysis and control mechanisms at all levels of data/information networks. Research is required in many areas before practical tools can be developed to address all of the problems of entropy, but some progress can be made with better knowledge of information theory. Giving focus to the problem by establishing even the most rudimentary analysis tools to measure entropy is essential, and this would be an objective of the DFM.

- INPUT recognizes that workable information systems networks are being designed by "experts" who intuitively know that you don't dump massive reports on top management--or filter essential operational information through excessive levels of management--and expect to have effective decision-making at the top.

- There is a need to extend decision support systems to knowledge-based systems, and if this is to be done it must be done with an understanding of data/information entropy. The productivity tools and aids mentioned thus far (IBM, DOCS, and DFM) are all designed to contribute to the general knowledge base from which specific expert systems can be developed.

- There is an important paradox in all that has been described above: the tools of OR and AI appear to be essential in developing tools and aids to control quality in the DSD environment. However, the very OR and AI tools required may result in quality control problems of their own; especially in the area of performance.

- Hans J. Bremermann, in his paper entitled "Complexity and Transcomputability" (The Encyclopedia of Ignorance, Pergamon Press, Ltd., 1977) points out that both operations research and artificial intelligence frequently require computational algorithms (OR) and searches through exponentially increasing alternatives (AI) that exceed the capacity of any computing resource on earth. In fact, some OR and AI "solutions" can easily exceed the capacity of any computer that can ever be built, and this is referred to as being transcomputable.

  - If the computational cost surpasses the limits governing the physical implementation of algorithms, that algorithm is transcomputable.

  - If the computational cost of an algorithm grows exponentially with a size parameter n, that algorithm is transcomputable for all except the first few integers of n.

  - Many algorithms of artificial intelligence and operations research are transcomputable.

- Therefore, the only advice which seems appropriate when developing necessary quality control tools and aids which employ OR and AI is to proceed with caution, but by all means proceed.

5. SECURITY, PROTECTION, AND PRIVACY (SPP)

- Everyone knows that security and protection of both public and private data bases present problems which will only be compounded in the DSD environment. Any system which is developed without proper attention to these problems runs a high risk of being either inoperable or subject to replacement.

- It is INPUT's opinion that even isolated cases of harassment of private citizens will soon lead to increased attention to the question of privacy, and this has additional ramifications:

  - There is the obvious potential for law suits, which will lead to the requirement for some type of guarantee that data bases are secure.

  - Privacy legislation requiring that access information be made available upon request will become more common, and requests for such information by individuals will increase. This will have substantial impact in several areas:

    . It will require a computer-based access and control system for paper-based files (similar to DOCS) and will accelerate conversion to the electronic office.

    . Most current data base systems will not be adequate to supply required access information, and will have to be either replaced or enhanced.

- Many current public data base services may be severely impacted.

- There will be substantial opportunities for expanded security, protection, and privacy hardware/software systems.

- The SPP problems associated with distributed data bases and information flow have been anticipated and substantial research has been done. However, even rudimentary SPP facilities are not currently being provided in most commercially available systems, and are certainly not being incorporated in most systems being developed in-house. The SPP problem is increasing in complexity exponentially, and even the linear advances in solutions are not being applied.

- Security hardware/software is going to be a big business for those who understand the problem and can provide even partial solutions that will extend the life of current systems, but this field contains at least as many problems as are anticipated in the DSD environment. More importantly, DBMSs and micro-mainframe links which do not provide at least state-of-the-art SPP facilities are not going to find a ready market.

- While it is beyond the scope of this report to even address the current state of the art in SPP (much less to present a solution), there are several important structural considerations which become apparent in the DSD environment:

  - SSP in the DSD environment should preferably be separated (isolated) from the various subsystems. For example, a central SSP module should serve IBMS, DOCS, and various DBMSs that operate in a distributed data base environment. This means a centralized system for paper documents, encoded data bases, and even voice messages.

  - While specific data base (or operating) systems might continue to incorporate their own SSP systems and procedures (for example, on a

local area network), the quality of these specific systems would be a controlling factor in the distribution of data/information. In other words, the SSP facilities incorporated in a DBMS (perhaps DB2) or an operating system (perhaps UNIX) could be a limiting factor in the distribution of data from a host system.

- SSP facilities should be as automatic as possible in the DSD environment. This implies centrally controlled encryption and management of access codes and keys. For example, keys and codes could be dynamic, based on the preference of the local organization or individual. This would permit multilevel and random security interrogation from the central source if that were specified by the user. The user would thus be left with responsibility for establishing the level of security deemed necessary, but implementation would be relatively automatic.

- The complex security problems of information flow in the DSD environment, while not readily solvable by known techniques, are best addressed for purposes of study and research by a central SSP in conjunction with the facilities of the DFM.

6. LANGUAGES

- It should by now be apparent that languages--whether they are classified as first, second, third, or fourth generation--are going to proliferate. However, these designations are vague at best, and INPUT, rather than adopting the standard designation of 4GL (for fourth generation languages), uses FGL (for fourth, fifth, or future generation languages). Languages are evolving, and whether natural languages or icons prevail is not the question--there is going to be a whole range of languages at the user interface, and this will become apparent in the electronic office.

- An aid to both productivity and the implementation of the quality control tools and aids described above would be a metalanguage that would incorporate the following:

- A standard representation for various FGLs (INPUT's definition) which would facilitate:

  . Communications among various systems and intelligent workstations.

  . The development of new languages at the user interface.

- The metalanguage would also describe communications and operating systems command languages in standard fashion to assist in tracking data/information flow, and would facilitate the implementation of quality control tools, especially in the performance area.

- The distribution of development activities to information centers and intelligent workstations could be enhanced to include all language interpretation (by the metalanguage), and provide a single language for the receiving system (whether host or distributed system).

• INPUT believes host systems are becoming either large data base machines or heavy number crunchers. If the relational model of data becomes prominent in the DSD environment (and in expert systems), large systems will be dealing with arrays (for heavy computation) and tables (if relational data bases). This leads INPUT to project that future large-scale system architectures (after Sierra) will reflect this requirement. For that reason, it would appear that this should be considered in the selection of a metalanguage. Without a great deal of analysis, the time may be right to consider APL (A Programming Language).

VI MARKET ANALYSIS AND FORECAST

VI MARKET ANALYSIS AND FORECAST

A. MARKET ANALYSIS

- Gross market forecasts for either hardware or software products are meaningless without analysis of IBM's presence in that market; and IBM does not have to have a product in order to have market presence. "IBM is the competition whether they have a product or not" is a quotation, from past INPUT research, that has been repeated many times--and it bears repeating: IBM is omnipresent.

- As INPUT pointed out in Market Impacts of IBM Software Strategies, the key to market analysis is to determine IBM's primary emphasis in particular software product areas and then contrast that with the predominant trend supported by technology. The general software market analysis for the 1980s and 1990s was presented in that report, and will not be repeated here--except to summarize briefly IBM's strategies and technical challenges, and resulting vendor opportunities for the current SNA/DDP strategic period and the electronic office period that follows.

    - IBM's predominant software direction during the remainder of the 1980s will be to maintain the highly centralized control inherent in host-oriented operating systems. This strategy is dictated by a dependency on revenue from large-scale processors and magnetic storage systems.

- The IBM strategy is challenged by: optical memory developments, off-loading of mainframes to minicomputers under UNIX, performance problems from unanticipated data/information entropy, and the potential problems in delivering enough MIPS with the Von Neumann architecture. This analysis of IBM's strategy translates into the following opportunities for competitive vendors during the late 1980s:

  . Support of optical memories in appropriate applications.

  . Support of off-loading of appropriate software functions to minicomputers and/or data base machines.

  . Anticipation and understanding of the problems of data/information entropy inherent in IBM's software strategy, and the importance of energy (processing power) conservation in such an environment.

  . Differentiation of languages and decision support systems.

  . Provision of tools for performance monitoring and for improvement of host systems and the network.

- During the early 1990s, IBM's predominant software direction will be toward integration into a new total office system of the diverse systems and products that currently complicate the issue of office automation. This strategy is dictated by IBM's need to grow from a \$100 billion company to a \$200 billion company during that period, and by the necessity for obsoleting all of its old office products in order to achieve this growth.

- The challenges IBM faces in doing this are significant: new operating systems and network management facilities will be required; alterna-

tives to IBM's solution may already in place; better competitive software may be available; and there may be sales resistance to electronic office technology from both labor organizations and user management. There appears to be a window of opportunity for the following:

- Integrated communications--outlined operating systems.

- Mechanization of languages down to the workstation level.

- Development of expert systems employing knowledge bases.

- Industry turnkey systems.

- IBM has the ability to adversely impact market acceptance--optical memories are an example--but its attempts to control technological acceptance creates opportunities as well. The above summary represents only a brief description of the impacts and opportunities represented by IBM's software strategies. The reader is encouraged to refer to <u>Market Impacts of IBM Software Strategies</u> in order to understand the significance of these conclusions.

- In determining the productivity tools and aids required in the DSD environment, the general shift in emphasis from the large-host-oriented SNA/DDP period to the LAN-oriented electronic office period was considered. Indeed, the shift is compatible with, and even symptomatic of, the DSD environment; however, the tools and aids outlined in Chapter V must now be analyzed in relation to IBM's software strategy, which is designed to maintain revenue growth through the sale of hardware.

- While IBM software revenue will be significant during the 1980s, it must be remembered that software revenue remains secondary to the primary objective, which is to support, prompt, and control hardware sales. This is important for several reasons:

- The pricing ramifications are obvious: when necessary to support initial hardware sales the software can be practically given away, as it was in the days prior to unbundling. However, as systems software is enhanced or corrected, the price tends to rise; and once complex hardware/software systems are firmly in place, prices can be adjusted with little regard for development or distribution costs, much less for value added.

- However, from the time of initial unbundling, IBM program products have been subject to normal product development procedures (forecasting, pricing, etc.). IBM doesn't like loss leaders, and the initial impetus toward unbundling was prompted as much by the desire to get the "programming mess" under control as it was to extract revenue from the customer. The discipline of the normal planning cycle has provided IBM with valuable insight into the potential economics of the software market (from IBM's point of view).

- For example, it would be surprising if IBM did not recognize the following:

  . IBM's software development costs are substantially higher than those prevalent in the software industry.

  . IBM's reputation as a software producer has not been good, either in the market or within IBM, and most "quality" software products have resulted from "bootleg" efforts outside the product development mainstream.

  . Nevertheless, IBM operating systems have probably contributed more to both account control and revenue, when resulting hardware sales are considered, than any other definable development effort in the company's history.

- However, at the applications package and subsystem level, it has been impossible to schedule a successful "invention" or best-seller.

- IBM does not have to have the best software product in order to lead the marketplace.

- IBM has a software distribution and maintenance system which cannot be duplicated by any potential competitor.

- Whereas the primary objective of IBM's software strategy during the 1980s will be to maintain account control and to sell hardware, IBM is also acutely aware that software/information is a high-growth area that will become increasingly important to IBM's growth. IBM's market strategy is very simple:

  - Since software/information will be increasingly important to IBM's growth, IBM must plan to dominate that market if it is to achieve its growth objectives.

  - IBM does not have the human resources in development to dominate the software market--in fact, that market is not at all clearly defined. In addition, even the amount of software necessary to support hardware sales is beyond IBM's current capability.

  - The fundamental answer to this dilemma is alarmingly simple if you happen to be IBM: if you can't dominate the software market through sale of your own products, become the world's biggest market for software. Buy the winners (or near-winners) and use your distribution and maintenance system to control the market through resale. Thus, IBM has stated: "We are looking for software worldwide," and they have the money, and even the deals, to acquire what they need.

- Software developers who want to take advantage of the world's best software distribution system (and sales organization) would do well to target their products at IBM as a potential customer, as well as at the current competition. IBM will make a lot of individuals and organizations wealthy with their acquisition of software products during the 1980s, but you can be sure of one thing--house brands will eventually appear, and they will receive preferential treatment.

- With IBM's ubiquitous presence in the software market established, it is now possible to look at the general structure of the software market as described in Market Impacts of IBM Software Strategies, and how the tools and aids needed for the DSD environment fit into that structure, as shown in Exhibit VI-1.

  - The Information Base Management System (IBMS) may be viewed as an application for managing both computerized and paper data/information dictionaries and directories. It differs from IBM's emphasis in the following ways:

    - IBM's current emphasis is upon integration of various encoded DBMSs (such as IMS, DB2, etc.). IBMS would mechanize communication and conversion across various systems (paper files and DBMSs).

    - From an applications point of view, IBMS runs counter to both IBM and GST directions (integration and differentiation), being a highly centralized application.

    - IBM's emphasis is upon highly centralized, host data/information/knowledge bases, and Business Systems Planning (BSP) and Information Quality Analysis (IQA) series are designed to facilitate centralization. IBMS is designed to accommodate diversity (libraries, personal data bases, etc.).

EXHIBIT VI-1

DSD SOFTWARE MARKET STRUCTURE
(SNA/DDP Period - 1984 to 1989)

					TOOLS & AIDS NEEDED					
SOFTWARE AREA	Integration	Differentiation	Mechanization	Centralization	IBMS	DOCS	DFM	OR & AI	SPP	FGL
Operating Systems										
Process	IBM	X						●		
Storage Management				IBM X		●			●	
Protection & Security		X		IBM			●		●	
Resource Allocation	X			IBM			●	●		
System Structure			X	IBM					●	
Hardware/Firmware/ Software			X	IBM		●	●	●	●	
Data Base Management Systems	IBM		X		●	●	●		●	
Languages, DSS	IBM	X						●		●
Industry Turnkey	X IBM	IBM	X	IBM						
Applications Software	IBM	X			●	●		●		
Data/Information/ Knowledge		X		IBM	●	●	●	●		

Key: IBM = Predominant IBM Direction

X = GST Direction

● = Primary Software Areas for Tools and Aids

- While the primary software areas for IBMS are those listed in Exhibit VI-1, there are obvious operating systems implications in the implementation of the various subsystems under IBMS (see Exhibit V-4).

- The Document Control System (DOCS) is one of the subsystems with obvious operating systems ramifications for storage management (with storage including magnetic disk, file cabinets, library shelves, and micrographics systems). While both IBM and DOCS emphasis is upon centralization, DOCS is much broader in scope, and points to a significant opportunity to exploit IBM dependency upon magnetic disk storage revenue during the SNA/DDP strategic period.

- For example, an advanced implementation of DOCS could include an integrated image processing system, as presented in Impact of Upcoming Optical Memory Systems (INPUT, April 1983), and as shown here in Exhibit VI-2.

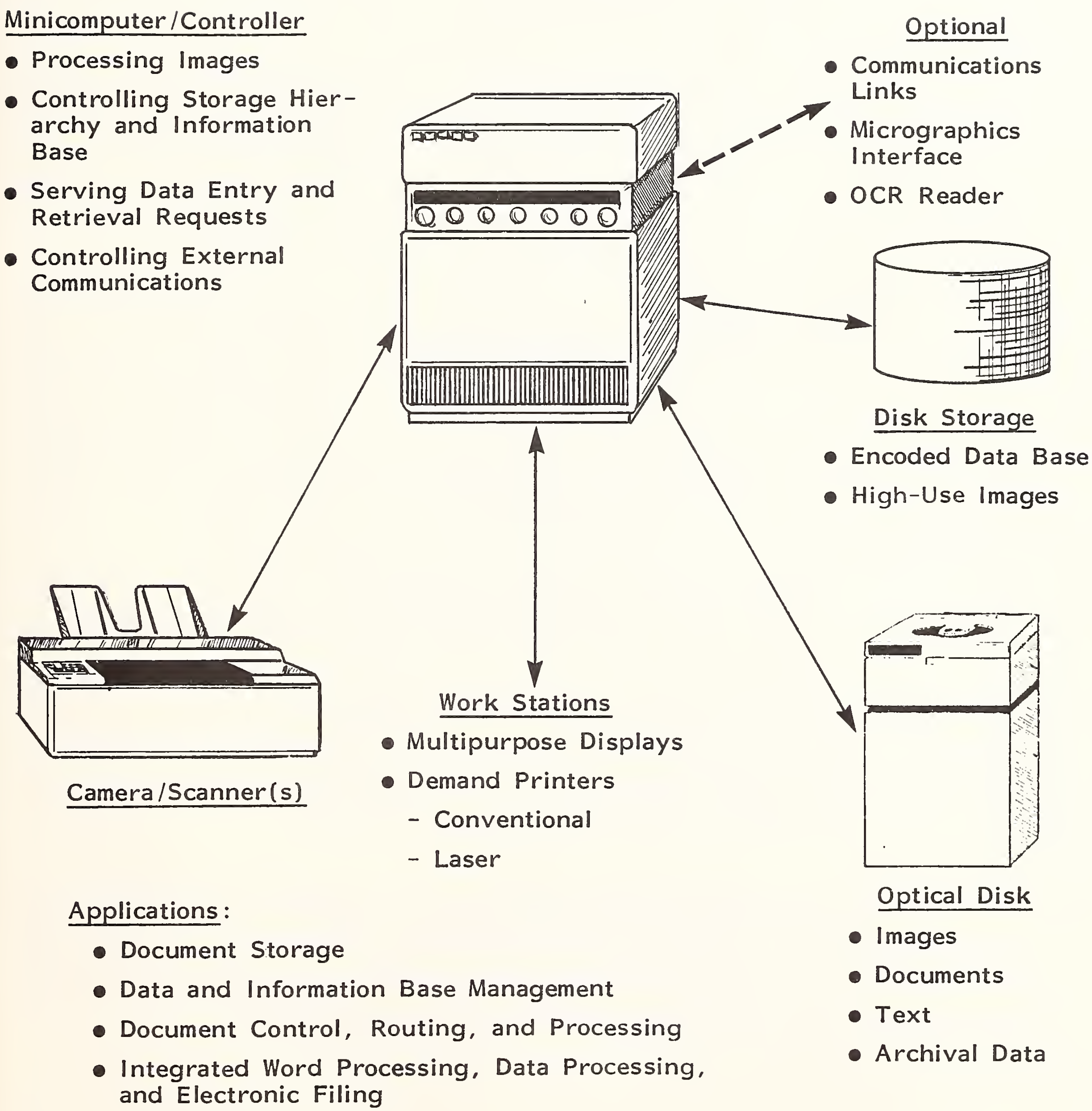
  - The system could incorporate IBM's Scanmaster, but would use optical disk for the bulk of document storage.

  - Pattern recognition (AI) is sufficiently advanced to permit updating of specific encoded data elements--such as document identification and specific transaction data--directly from the document being entered.

  - The specific implementation using a minicomputer or specialized controller also runs counter to IBM's continued strategy of centralized general pupose hosts, which means there is probably a substantial window of opportunity.

EXHIBIT VI-2

INTEGRATED IMAGE PROCESSING SYSTEM



- Variations on this type of system are needed now in order to prepare for the electronic office strategic period.

- The Data Flow Monitor (DFM) depicted in Exhibit V-5 is really an extended network management facility. As such, it has obvious ramifications for IBM's continued heavy centralization of communications functions in the host computer.

  - The use of specialized processors (minicomputer or microprocessor) and optical memory technology (disk and tape) as DFM is implemented at various levels in the computer/communications network, providing a clear opportunity for alternatives to IBM's strategy during the SNA/DDP strategic period.

  - IBM's snail-like progress in communications front ends (3705, 3725 etc.) and its refusal to make hardware performance monitors available, except as a "service" in competitive situations, practically guarantee that imaginative implementations of DFM (or portions thereof) will not have direct competition from IBM in the marketplace.

- The tools of operations research and artifical intelligence cut across all major software areas, and in the sense they are being defined here, they actually represent tools to build tools. IBM has substantial AI research under way, including its support of university AI programs. Once again, windows of opportunity exist where IBM is reluctant to provide new hardware technology--specialized processors (such as LISP machines) or storage technology.

  - INPUT feels, however, that IBM will first employ optical memories in advanced education systems and in early expert systems, so the window of opportunity based on employing that particular technology may not be significant.

- Nevertheless, expert systems are really education systems in the broadest sense, and the need for such systems to support the systems development process is virtually unlimited.

- Security, protection, and privacy (SPP) problems associated with the DSD environment, and specifically with distributed data bases, represent a tremendous potential market that is ideally suited for IBM ("whom would you rather sue?" was the question raised in Impact of IBM Software Strategies). From IBM's perspective, it has everything--an ideal means of account control, an argument for SNA, an essential thread for software at all levels in the processing hierarchy, and hidden hardware sales. It is extremely important to lead IBM in providing solutions to SPP problems--products which do not provide adequate security are not going to sell. SPP requires substantial additional research, both from a technical point of view and in terms of market analysis.

- Fourth, fifth, and future generation languages (FGLs) are the driving force behind the DSD environment. They will become the means of making computer power available to everyone. IBM is confronted with integrating languages at various software levels under its highly centralized, host-oriented strategy.

  - The opportunities for FGL differentiation (and mechanization) are substantial, but the quality problems identified in this report are real and will severely impact market opportunities unless they are addressed.

  - FGLs must address performance problems and be implemented in an environment where quality has been restored to the base of the productivity pyramid. The FGLs that are integrated with necessary tools and aids for quality control are going to be the successful ones.

B. FORECAST

- INPUT has forecast systems software markets in the United States for three major areas:

  - Applications development has been projected to grow from $1.8 billion in 1983 to $10.3 billion in 1989. This represents an average annual growth rate (AAGR) of 34%.

  - Systems control has been projected to grow from $1.1 billion in 1983 to $4.1 billion in 1989, for an AAGR of 24%.

  - Data center management has been projected to grow from $0.65 billion in 1983 to $2.2 billion in 1989, for an AAGR of 23%.

  - Overall, the entire systems software market is projected to grow from $3.5 billion in 1983 to $16.7 billion in 1989, for an AAGR of 29%.

- INPUT has also forecast that FGLs (including generalized tools, DBMS tools, code generators, and modeling languages) will increase from $0.75 billion in 1984 to $3.7 billion in 1989. However, this forecast was adjusted during the last two years to reflect the impact of emerging expert systems (Trends and Opportunities in Fourth Generation Languages, INPUT, 1984). This report suggests that expert systems will merely reflect language differentiation (tools to develop expert systems) and mechanization (actual expert system implementation), and should be covered under the broad INPUT category of FGLs.

- INPUT also predicted that IBM's worldwide software-related revenue (both applications and systems) would increase from $2.3 billion in 1983 to approximately $12 billion in 1989. At present, INPUT estimates that 90% of IBM's revenue is from systems software, and 75% is from domestic sources. When

applied to the domestic systems software market, this results in the following projections (see Exhibit VI-3):

- The total market for systems software is forecast to be over $16 billion in 1989, but that market must be reduced by nearly 50% (46.7%) if IBM is conceded its "share" of $8.1 billion. Therefore, the effective market for systems software is "only" $8.9 billion.

- The total systems software market is broken down into the three major categories mentioned earlier: applications development, systems control, and data center management.

- IBM penetration of the three major systems software categories is not distributed equally. Examination of these categories permits a rough estimate of IBM penetrations by 1989.

  - Systems control includes the following subcategories:

    - Access control.

    - Communications monitors.

    - Network control.

    - Operating systems.

    - Security systems.

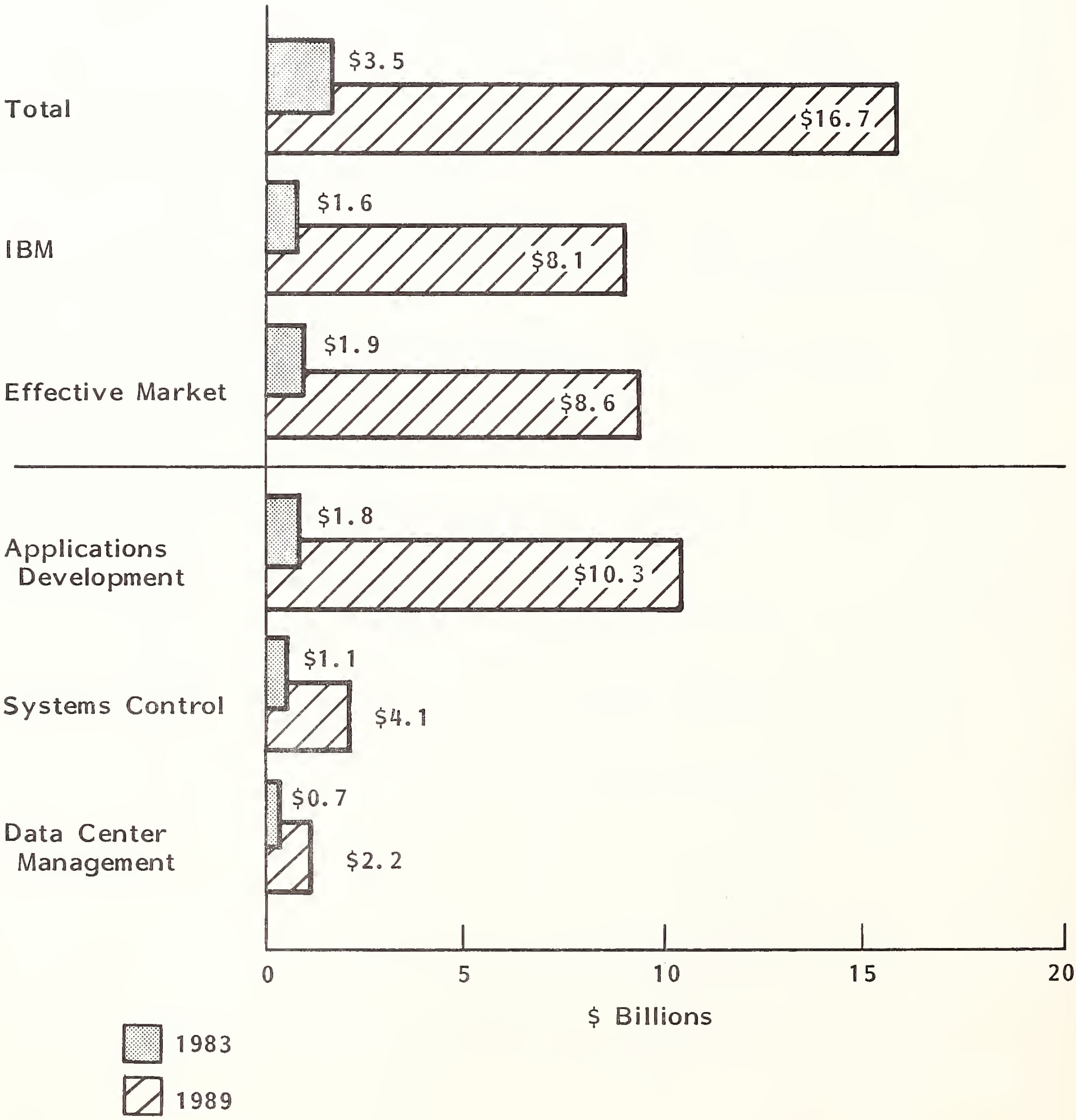
    - Systems library control.

    - Windowing systems.

    - Others.

EXHIBIT VI-3

SYSTEMS SOFTWARE FORECAST
(1983 to 1989)



- Data center management includes the following subcategories:

    - Capacity management.

    - Computer operation scheduling.

    - Data center management.

    - Disk management.

    - Downtime/repair monitoring management.

    - Job accounting.

    - Performance monitors.

    - Tape management.

    - Utilities.

    - Other.

- Applications development is divided into two categories: program development and production tools, and data base management systems. These include the following subcategories:

    - Applications generation.

    - Assemblers.

    - Automatic documentation.

- Compilers.

- Debugging aids.

- Languages (all generations).

- Systems development control.

- Retrieval systems.

- Translators.

- DBMSs.

- Data dictionaries.

- Others.

- It is estimated that IBM penetration of the three major systems software categories in 1989 will be as follows:

  - Systems control--75% ($3.1 billion).

  - Data center management--35% ($4.2 billion).

  - Applications development--41% ($4.2 billion).

- This means the effective market for other competitors in the three major systems software categories in 1989 will be as follows:

  - Systems control--$1.0 billion.

  - Data center management--$1.4 billion.

  - Applications development--$5.1 billion.

- It is also apparent that the tools and aids needed to maintain quality in the DSD environment and to prepare for the transition from the SNA/DPP period to the electronic office period cut across many of the subcategories of systems software. In addition, IBMS and DOCS (in some of their possible implementations) could be classified as a cross-industry segment of applications software (forecast by INPUT to be a $10.2 billion market by 1989). The research done during 1984, and the rapidly expanding and changing software industry, disclose the need for a new software structure to reflect the realities of the marketplace. INPUT will do this during 1985.

- However, for purposes of this study, we shall classify the tools and aids outlined in this report as extensions of FGLs. An "invisible FGL market" for application-specific software was identified in Trends and Opportunities for Fourth Generation Languages, and the tools described in this report may be viewed as making that market visible.

  - It is forecast that the tools and aids described in this report will add $1.5 billion to the original FGL forecast of $3.7 billion in 1989.

  - Therefore, the total market will be $5.2 billion, for an AAGR of 47%.

  - To a large extent, this high growth rate results from a broad interpretation of FGLs and the inclusion of the invisible market. However, it is INPUT's opinion that unless the questions of data/information quality and systems performance are addressed by FGLs, they will prove to be self-defeating. We are betting that will not happen.

  - It is also forecast that IBM penetration of this market by 1989 will be only 30% ($1.5 billion), leaving a total effective market of $3.7 billion.

VII CONCLUSIONS AND RECOMMENDATIONS

VII CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

- In an effort to improve productivity and the responsiveness of the IS function, the general trend during the last five years has been to get end users more involved in the systems development process. This trend manifests itself in the following ways:

  - An increased emphasis upon information centers, with strong endorsement from major vendors--specifically, from IBM.

  - The enthusiasm for prototyping as an integral part of the systems development process.

  - The proliferation of standalone personal computers, which gave considerable incentive to the IS function to get end users involved.

  - The rush to link micros to mainframes--which is IBM's way of establishing control through its highly centralized, host-oriented systems network architecture.

- INPUT refers to this general trend as Distributed Systems Development (DSD).

- INPUT, while recognizing that user involvement in the systems development process is important, has stressed that any program of productivity improvement must be built on a basis of commitment to quality. In the results-oriented DSD environment, commitment to quality has been relegated to relatively low priority.

- There is currently a high risk that the DSD environment will result in the following:

    - The development of systems with such poor performance that they will exceed the capacity of host mainframes (or at least cannot be cost justified).

    - Data base synchronization and integrity problems that may in turn result in the rapid deterioration of data quality.

    - Data base protection and security problems, which are currently not understood--much less solved.

    - The contamination of essential information flow with conflicting and inaccurate reports.

- The tools and aids used to facilitate the DSD environment--by their very effectiveness--will contribute to the quality problems that are anticipated. To the degree that products (specifically FGLs) do not address these problems, their use will be limited. On the other hand, products which do address the problems of quality that have been outlined represent an outstanding business opportunity.

- IBM's traditionally conservative approach to distributed processing under SNA is essentially designed to maintain revenue growth from host hardware. This IBM emphasis upon centralization will continue through the 1980s (SNA/DDP period); and, considering the problems outlined above, a good argument can be

made that this strategy is precisely what is required. However, by understanding IBM's strategy, substantial windows of opportunity become apparent--especially in anticipation of the advances in office automation expected in the early 1990s (electronic office period).

- FGLs (by INPUT's definition) have been the driving force behind much of the DSD environment, and INPUT concludes that they can be extended conceptually to include a full range of applications development products, including those associated with quality control and emerging expert systems.

- A holistic view of software systems is necessary in order to give general structure to a complex problem. (This necessity was first recognized by the application of general systems theory concepts in Market Impacts of IBM Software Strategies.) The DSD environment requires an emphasis on software systems that address data/information flow, rather than on the more static concept of software packages. Otherwise, basic design conflicts occur.

- INPUT concludes that analysis, restructuring, and redefinition of the software market is essential if more meaningful product forecasts are to be made. It will be a primary corporate objective for INPUT during 1985.

B. RECOMMENDATIONS

- Vendors should understand IBM's hardware/software strategy and its impact on the software market. Like it or not, IBM's strategy will define both the market and the opportunities for competitors. A software product strategy which is synergistic with IBM's is not only desirable, but may become essential for survival. INPUT recommends Market Impacts of IBM Software Strategies as a place to start. It is somewhat complex--and you may not agree with portions of it--but it does provide a general frame of reference for the market.

- Recognize and understand the seriousness of the potential quality problems associated with the DSD environment and the fact that many current tools and aids are contributing to the problem. Develop products which become part of the solution rather than remaining part of the problem.

- Identify hardware/software products which IBM has little current incentive to develop because of possible impact on its business plan. Associate those products with the problem solutions of the DSD environment.

- Develop products synergistic with IBM's strategy, in the sense that they fill needed gaps and solve real problems.

- View IBM as a separate potential market for software products where their software product line is deficient and they need software to pursue their strategy. When possible, consider this potential market during product design.

- Take a holistic approach to solving the productivity problem, with special emphasis upon systems quality as the primary design point of tools and aids.

- Tap the invisible market by developing applications systems that address data/information flow quality during the transition from the SNA/DDP period to the electronic office period.

- The representative tools and aids presented in this report at least roughly indicate potential areas of opportunity in software productivity, and they will be refined by INPUT in the future.

APPENDIX: USER QUESTIONNAIRE

APPENDIX
USER QUESTIONNAIRE

1. In 1980 your company was interviewed as part of INPUT's comprehensive study on improving productivity in systems and software development. In the last four years, do you feel that productivity in your company has:

☐ Improved Substantially

☐ Improved Some

☐ Remained the Same

☐ Decreased

☐ Decreased Substantially

2. What do you feel is the most important change that has occurred (in your company) and has influenced productivity?

____

____

____

3. Do you currently employ a systems design methodology in your systems development cycle?

a. ☐ Yes ☐ No

b. If yes, which one(s)?

____

____

c. How do you personally feel about it?

☐ It is a substantial aid to development.

☐ It helps some.

☐ It is just common sense.

☐ It doesn't help very much.

☐ It creates a lot of work.

4. Do you currently employ programming aids during the normal systems development cycle?

a. ☐ Yes ☐ No

b. If yes which one(s)?

____

____

____

c. How effective do you personally feel these tools and aids are? (Identify which.)

1	2	3	4	
____	____	____	____	Very Effective
____	____	____	____	Somewhat Effective
____	____	____	____	Not Very
____	____	____	____	A Waste

5. It is INPUT's conclusion that the most noticeable change in the systems development process in the last four years has been to get end users directly involved. INPUT refers to that change as Distributed Systems Development - DSD. Do you currently:'

	Yes	No	Planned
Have an Information Center ?	☐	☐	☐
Use prototyping? (with end-user involvement)	☐	☐	☐
Make significant use of PCs? (Significant use means that some of the end users are doing work that would have formerly been done by IS.)	☐	☐	☐
Are PCs linked to mainframes?	☐	☐	☐

6. We would like to get your opinions about DSD in general. Do you agree or disagree with the following statements?

	Agree	Disagree
It has relieved user pressure on IS.	☐	☐
End users are happier.	☐	☐
Systems get done faster.	☐	☐
Programs get done faster.	☐	☐
Backlog has been (or will be) reduced.	☐	☐
DSD helps IS do its job.	☐	☐
DSD is going to cause problems.	☐	☐
End users don't know what they are doing.	☐	☐
IS productivity is improved.	☐	☐
End-user productivity is improved.	☐	☐
Corporate productivity is improved.	☐	☐
The systems will have to be rewritten by IS.	☐	☐

7. What are the main advantages and disadvantages of:

a. Information Centers

Advantages: ______________________________

____

Disadvantages: ______________________________

____

b. Prototyping

Advantages: ______________________________

____

Disadvantages: ______________________________

____

c. Standalone PCs

Advantages: ______________________________

____

Disadvantages: ______________________________

____

d. Micro-Mainframe Links

Advantages: ______________________________

____

Disadvantages: ______________________________

____

8. Past research has indicated that systems maintenance is the most costly part of the system's life cycle. What impact is DSD going to have on maintenance?

____

____

9. What tools and aids are currently being used to facilitate end user systems development? (Ask for both name and vendor).

Name	Vendor

10. How are these tools and aids selected?

IS User Combination

11. A great deal of apprehension has been expressed about micro-mainframe links. How serious do you consider the following potential problems?

	Very Serious	Somewhat Serious	Not a Problem
Data Base Synchronization	☐	☐	☐
Data Base Integrity	☐	☐	☐
User Understanding of Data	☐	☐	☐
Conflicting Reports to Management	☐	☐	☐
Mainframe Capacity Planning	☐	☐	☐
Mainframe Performance Impact	☐	☐	☐
IS Visability	☐	☐	☐
Cost to Company	☐	☐	☐
Impact on IS Budget	☐	☐	☐
Systems Quality	☐	☐	☐
IS Loss of Control	☐	☐	☐
Data Security/Protection	☐	☐	☐

12. a. What are you currently doing about these potential micro-mainframe problems?

____

____

b. What do you plan to do? _______________

____

13. What tools do you need to facilitate DSD? _______________

____

____

14. What tools do you need to control DSD? _______________

____

15. Have you either considered or heard of any tools for facilitating or controlling DSD that you consider promising? Specify name and vendor.

____

____

16. Compared to four years ago, how receptive are you to:

	More	Same	Less
Applications Packages	☐	☐	☐
Industry Turnkey Systems	☐	☐	☐
Outside Processing Services	☐	☐	☐
Outside Systems & Programming Assistance	☐	☐	☐
Fourth-Generation Languages	☐	☐	☐

17. How do you measure productivity improvement?

____

____

____

18. What is your understanding of knowledge-based or expert systems?

____

____

____

19. Do you anticipate that expert systems will be developed internally or purchased?

a. ☐ Purchased ☐ Developed

b. If developed internally how would they impact productivity of IS?

____

____

c. How do you feel expert systems will effect productivity of those using them?

____

____

20. How do you cost justify the purchase of productivity improvement tools and aids?

____

____

____

21. Any additional comments concerning productivity improvement?

____

____

____